75A-4 Modification Compendium

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75A MODIFICATIONS

by

Collins' Engineering Staff

Collins Radio Company
Cedar Rapids, Iowa
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TABLE OF FIGURES

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Introduction

This compendium came about as a result of the interest created by the last part of Ray Osterwald's, (NØDMS) series in ER on the Collins 75A-Series receivers (The Collins 75A-Series Receivers: A Legacy of High Quality). Part 6, 75A-4 Modification Summary, ER #47 listed all the 75A-4 modification articles that have been published in the ham magazines up to this time.

Many subscribers to ER called or wrote requesting copies of these modification articles. This high amount of interest prompted me to put this compendium together.

Barry Wiseman, N6CSW
Editor Emeritus, Electric Radio

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The Collins 75A-Series Receivers: A Legacy of High Quality

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Part 5: The 75A-4 and the Single-Sideband Era

Why is it that a ham receiver first produced thirty-seven years ago, in terms of basic receiver performance, is still fully competitive with contemporary designs? What is there about the 75A-4 that makes it so intrinsically "radio" that their owners become very unwilling to change? Is it because the A-4 may be fixed with only a VTVM and a soldering iron? Is it the feel of the comfortably large and velvet-smooth vernier dial placed at exactly the right height on the panel? Maybe it could be a quiet moment in the shack, when the translucent kilocycle dial is illuminated in the warm glow of a type 47 lamp that we get attached to. Or, maybe it's the big Simpson S-meter we remember, as it kicks up sharply, announcing that the DX station you've stayed up so late for has finally arrived. It also might be the super-sharp selectivity that's available, as fellow net members are quickly separated from band noise. Surely it couldn't be the fact that the rig was made in Iowa, USA, could it? It is probably not one single thing so much as a combination of all its features that produces this devotion.

Designed to be a high-performance, single-sideband receiver, the 75A-4 did not neglect the other modes and operators, and offers equivalent high performance. Being totally new inside and outside, it was nearly 4 inches narrower than previous A-line receivers, and considerably lighter. It began the trend towards smaller and lighter radio equipment.

All of the unique circuitry in the receiver was developed in a special post-war engineering program which was set up and personally directed by Art Collins. By late 1953, this special team had begun to show some good results of the five or so years of work in new circuit concepts and hardware design. Their progress can be followed indirectly today by scanning the Collins ads which were entitled "SSB Engineering Notes" in the ham magazines of the period. Ernie Pappenfus, K6EZ, was a Collins engineering supervisor in Cedar Rapids at the time. His involvement came when, as he puts it, "Art Collins grabbed a bunch of my engineers and assigned them to a special project team that was headquartered in a little metal building behind the Collins main plant. The sideband circuits used in all of the later equipment came out of this group. We developed the product detector circuits, further improved the stability, reduced audio distortion, and did the other things that were required for good single sideband operation."

It should be pointed out that although Collins designed original circuitry and improved existing basic designs, we should remember that it was Edwin Howard Armstrong who gave us the principles of regeneration and heterodyne signal conversion, which are put to such fine use in the 75A-4.

Engineer Gene Senti, WØROW, took designs from the SSB project team and combined them with what had been learned to date with the existing 75A-series receivers, producing what we know today as the 75A-4. Introduced in March,

Collins 75A-4, S/N 5396. This receiver left final test at the factory 6-6-58, and was purchased 1-7-59 by Wendell Fletcher, K6KOJ, at dealer Gil Severns, Hemet, California.

1955, it was, along with the KWS-1 transmitter, the first Collins equipment designed expressly for single sideband service. QST reviewed the 75A-4 in the "Recent Equipment" column for April, 1955. Over the years, thousands of operators have come to develop a great respect for this receiver and for its capabilities.

Mr. Senti, as with all of the great engineers of his time, is relatively modest when it comes to talking about his life's work. He did mention that "When you're working on a receiver, you spend a lot of time in the screen room!" I asked him what the toughest obstacle was that he overcame during the 75A-4 design process: "Well, getting Mr. Collins' OK on it was the toughest! He was very active in the design. He knew what was going on with the project every day, and would be always looking over your shoulder. He would usually try the new equipment out at his house. He had a real nice ham shack out there with nice beam antennas, and I spent many an evening there, making changes that he wanted to suggest—' try this', or 'move that over there', or 'let's try these instead'. (It's obvious that the 75A-4 embodies whatever performance that Art Collins thought a good receiver should have.)"

"Generally, we'd build one or two of what we'd call an engineering breadboard, which was a pretty shaggy looking thing, with resistors pasted on resistors to get values zeroed in. Then we'd build maybe two engineering models, which had basically the same circuit as the breadboard, but were prettier to look at and nice enough to take some pictures of for advertising brochures and so forth. Right off we'd build a pilot run in the factory of maybe 20 to 50 units. Quite often these were sent out to various dealers and friends of Mr. Collins for evaluation. They'd use them for several weeks and

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make comments about them. Also any problems which showed up during that preproduction run would be taken care of. Then, generally we'd build a thousand units at a time on most of the ham gear. That was done in a little factory about 20 miles out of Cedar Rapids, a little farming community called Animosa. The ham gear was put together by farm gals, mostly. They knew how to give you a day's work for a day's pay. They were very good people and were very conscientious. The ham gear was built out at this place right until the 'bitter end'.

"As soon as Rockwell took us over, they figured out that ham equipment was just a loss leader and decided to drop it, and start making money on military contracts. So they dropped the ham gear just like a hot potato, but they kept the service department for a year or so, and then it was dropped too. I pity the poor guys out in the field who don't have any connections and have to scrounge parts. I see the prices of the parts in some of the magazines and catalogs and it is sometimes as much as the equipment cost new!"

In addition to being a new standard of comparison in communications receivers, the 75A-4 also made significant contributions to national defense and to the maintenance of world peace, something not much other ham gear can claim. Shortly after the introduction of the new amateur SSB line, the Collins Radio Company became involved in a very unusual project with the United States Air Force. Known as 'Project Birdcall', this was a joint effort between Art Collins and two Air Force generals, and convincingly demonstrated the effectiveness of single-sideband radio on world-wide communications circuits. Ernie Pappenfus and his engineering department was directly involved in this work. Here are his recollections:

"I went on several SAC (Strategic Air Command) flights all over the U.S., down to Texas, and to some other places testing single-sideband equipment for the Air Force. We operated all bands from a big old Air Force transport plane. On the plane, we had installed a brand new 75A-4 and a KWS-1, into which we had plugged special sets of Air Force crystals to get us on their command frequencies. Collins had set up a big communications station at the engineering building in Cedar Rapids, later called Communications Central. If the Air Force couldn't communicate with their network around the world for some reason, the Cedar Rapids station would jump in and assist them, as we had some high-power transmitters at the time, 50 kilowatt for sideband. The Collins station also assisted on some of the Presidential flights.

"The way these world-wide tests started was because General Curtis LeMay and General Butch Griswold were the Commander and Vice-Commander of SAC, and both of them were hams. They were familiar with the 75A-4 and the KWS-1 equipment, and one day they came over to the plant and talked to Arthur Collins about single sideband. A few weeks later, in the engineering lab, we made a special setup, which used a 75A-4 and a KWS-1 for single sideband service. Later, we did a permanent installation in a big C-97 Air Force plane. The equipment ran on 400 Hertz AC, and worked quite well there. There was no modification necessary to the power supplies to run at that line frequency. Eventually, SAC dispersed that plane all around the country, and then later to Turkey, Spain, and way out into the South Pacific to test single-sideband. They would have a radio roll call every hour to make sure they had communications, because at that time we had airplanes in the air with atomic bombs on them that had to be ready to go at any minute.

"On most of the test flights Art Collins was along with them, as he was a licensed pilot and interested in aviation. After two dead stick landings with his Bonanza, he decided that he wasn't going to be flying any more!

A 75A-4 and KWS-1 aboard an aircraft during the period when the airforce was evaluating SSB for military use. Photo courtesy of Harry Snyder, WØRN.

"The whole single sideband Air Force program started because of the 75A-4 and KWS-1 we installed on that SAC plane. We demonstrated the equipment, and they realized just how far they could talk with single sideband, compared with the old stuff they had. They decided that they really had to have it in order to have command and control of their airplanes while in the air. I think single sideband and the 75A-4 probably kept us out of a war.

"The Collins airborne installation was used for a couple of years, I think, starting around late 1955 or early 1956. After they saw how successful it was, the Air Force let a contract to Collins to develop the high power transmitters and the specialized communications equipment they needed, including the ARC-58, which was a single-sideband, multi-channel airborne set that we made thousands of.

"As far as I know, there were never any green 75A-4s for the military. As far as I can remember we never painted any a different color, and none of them was specially built under mil spec."

75A-4 CIRCUIT DESIGN

The 75A-4 is crammed full of circuit goodies originally developed out in that little tin building at Cedar Rapids. From Ed Andrade's product detector, to Gene Senti's passband tuning, the 75A-4 introduced circuit concepts still enjoyed in more modern equipment. It really represents an entirely new design philosophy from the rest of the A-line receivers.

The 75A-4 front-end represents a major design philosophy change from any other HF receiver of the period. The Collins SSB

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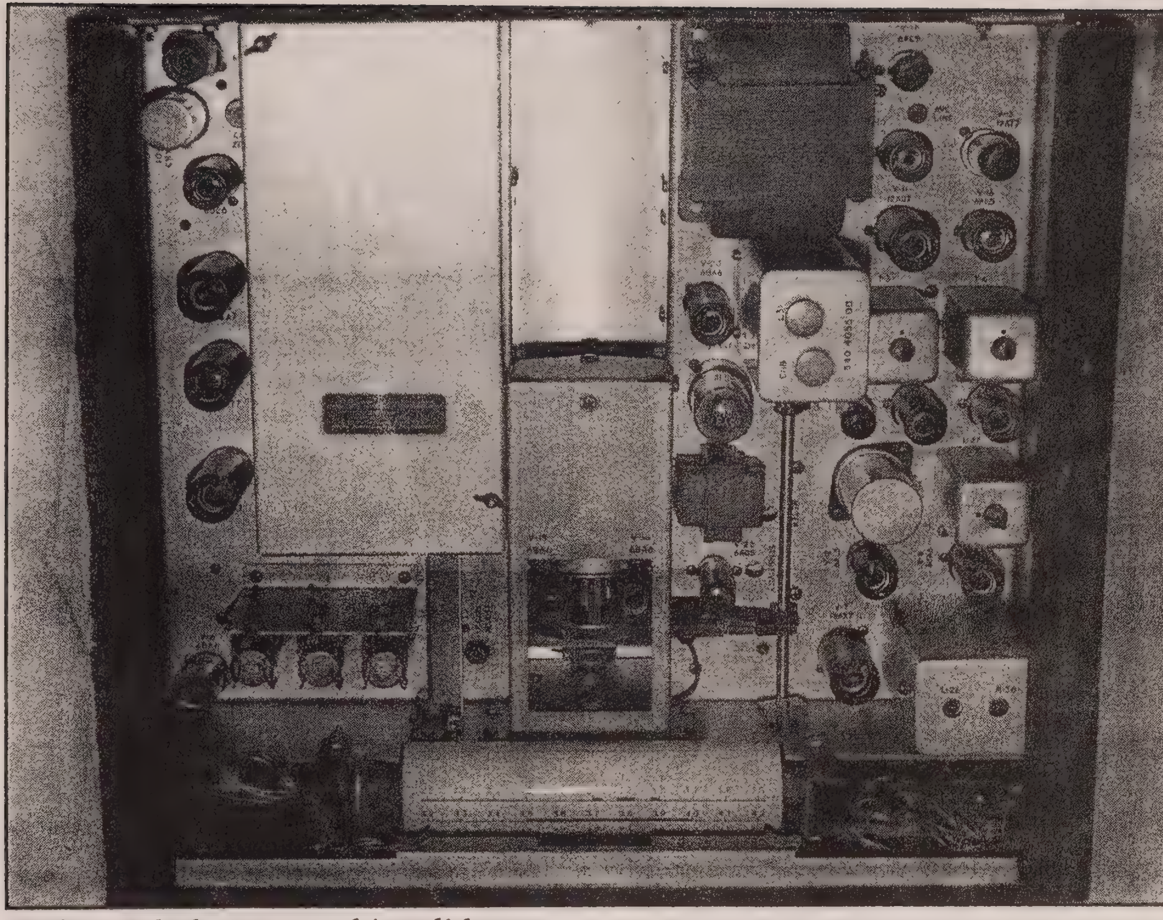
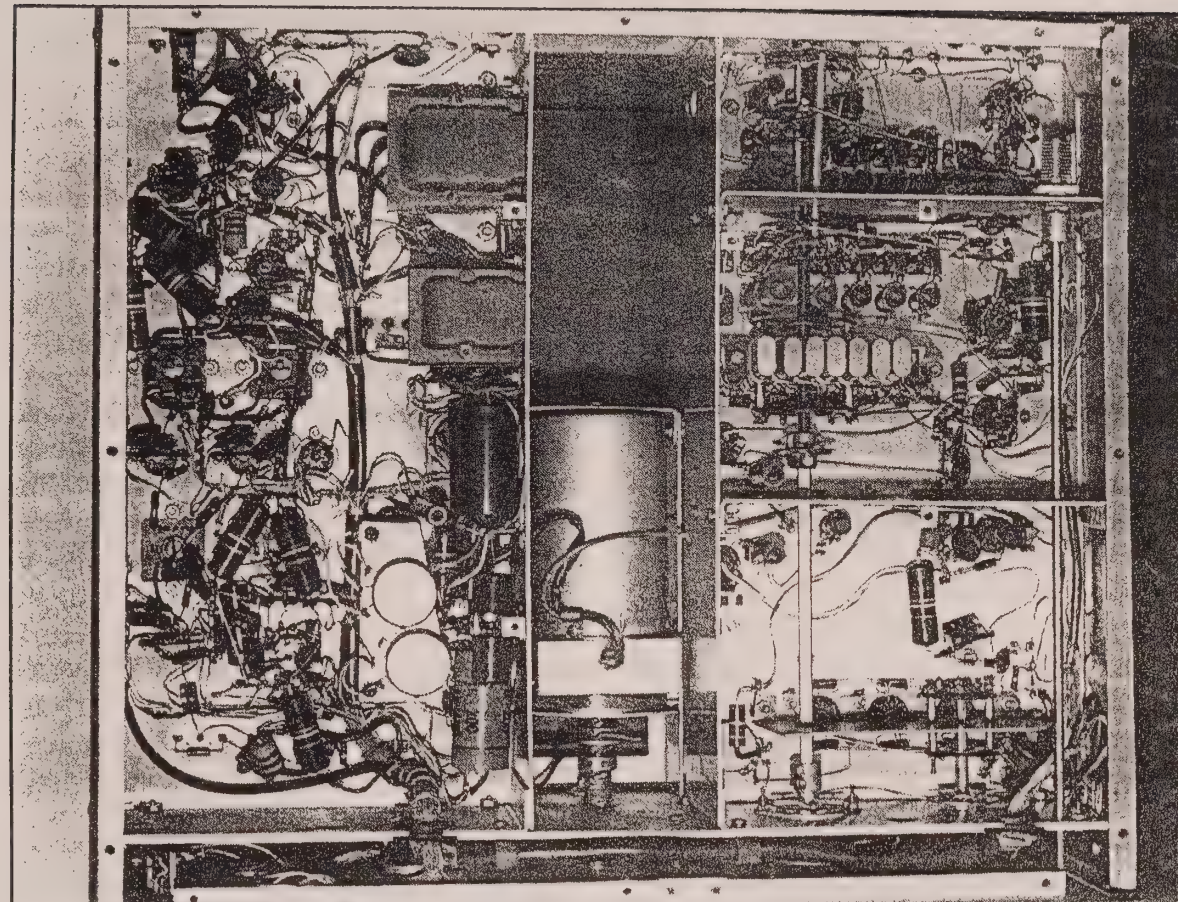


Underneath the 75A-4 cabinet lid.

project team recognized that given typical noise levels, a 7-to-10 dB receiver noise figure is perfectly adequate 90 percent of the time, even on 10 meters. Therefore, extreme sensitivity was traded off for the higher dynamic range figure needed in the increasingly crowded HF radio environment. This was accomplished with the 6DC6 pentode amplifier, the standard front-end tube for Collins until the S-line was discontinued. The remote cut-off 6DC6 was developed for television receiver front-ends, where similar problems with IMD were encountered. The 75A-4 is 14 dBm less sensitive than the 75A-3 or 75A-2, at -127 dBm. However, the dynamic range has improved significantly. My evaluation receiver, in factory stock configuration, measured a blocking dynamic range of 90.2 dB. The 2-tone, third-order dynamic range measured 88.3 dB. These numbers confirm what is already known, that the 75A-4 is in the "high-performance" class of receiver.

Another significant change is the inclusion of a built-in 100 Kc. calibrator, which uses a 6BA6 in a modified Pierce crystal-controlled oscillator. A Pierce oscillator operates in the parallel-mode for stability. The oscillator portion of this circuit is actually a Pierce "triode", in which the pentode screen serves as the equivalent triode "plate". The cathode and suppressor are bypassed to ground, forming an electron-coupled oscillator, which prevents changes in the plate load from pulling the oscillator frequency. This calibrator has good short-term stability. Although the crystal is mounted in a sealed can and uses a ceramic socket, long-term drift is a problem, and the calibrator must be frequently re-set. There have been some modifications published to increase the calibrator marker level on the 10 and 15 meter bands by directly substituting a 6BZ6, and this works well.

In order to have the same tuning rate



Bottom view of the 75A-4. The cabinet serial number reads 5396. Other records indicate a "factory serial number" of 5-396 and a "customer serial number" of 396. This might be part of the reason S/N's are not sequential.

on 10 meters as on the lower bands, an additional position on the bandswitch was added, giving a 10 meter "low" and a 10 meter "high" selection. The low portion tunes 28-29 Mc., and the high portion tunes 29-30 Mc. This requires an additional bandswitch deck in the RF amplifier plate circuit because of the added trimming capacity, and an extra crystal position was required for the 1st crystal oscillator grid and plate circuits. Also, the 10 and 11 meter bands were given their own antenna coils, to further increase image rejection.

In connection with the additional 10-meter switch position, the 1st variable IF bandpass is now 2.5 to 1.5 megacycles on all bands. 6BA7's are retained as the first and second mixers, and the double-tuned first mixer output is unchanged from the earlier receivers.

A newly-designed PTO, a type 70E-24, was used in the 75A-4. Its electrical design is similar to that of the others, but it is stronger mechanically, and critical component selection provides even higher stability than before. Its output range is 1.955 to 2.955 Mc., to produce a fixed 455 Kc. IF from the second mixer.

The 75A-4 design fully integrated mechanical filters into the IF amplifier strip, by allowing up to 3 of them to be plugged into chassis sockets, and to be selected from a front-panel switch. In contrast to the military receiver designs, there are no ceramic trimmers on the filter terminations in the 75A-4, probably a cost-saving measure. To make up for filter insertion losses, a 6BA6 pentode amplifier directly follows them.

Following the fixed selectivity provided by the mechanical filters is a variable

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notch filter, of a new design which replaced the venerable crystal notch of the 1930s. This new filter uses both halves of a 12AX7. The first half is a cathode follower which is used to feed a regenerative amplifier, the second half of the tube. The cathode follower serves to buffer the amplifier's input voltage. The regenerative amplifier has a variable bridged-T filter in its plate load, and being a series-tuned circuit, it provides a deep null at resonance.

Normally. a variable bridged-T filter won't provide a deep notch when used in IF circuits above 100 Kc. However, in the 75A-4 circuit, the effective Q of the plate filter coil (L26) is raised by means of the Q multiplication action in the regenerative amplifier. This gives an effect similar to a crystal notch, but avoids the distortion which is so typical of the IF response curve on either side of the crystal notch. The adjustment resistor, R36, gives the deepest null when set at 1/4 of the resonant impedance of the tuned circuit.

Unfortunately, due to short-term drift of the filter components, a careful alignment of the rejection filter circuit to provide the deepest notch usually doesn't last too long, and the long-term effective notch depth is less than what was available with the 75A-3's crystal notch. Hand-selection of C73 and C74 to provide the lowest possible temperature coefficient will help, but they are inside the filter can and are hard to get at.

As if a sharp rejection notch working against the steep skirts of a mechanical filter wasn't enough, Mr. Senti also gave us mechanical "passband tuning". This is a scheme where the rear of the PTO can is mounted in a bearing, and connected via a flexible metal strap to the shaft of the BFO tuning condenser. When the operator moves the passband tuning control, he can change the position of the interference relative to the fixed mechanical filter skirts, without changing the beat note or the dial frequency. There is no separate BFO pitch control. The effect is to "shove" interference outside the filter skirts, and it is extremely effective when the system is in proper alignment. Note that in this arrangement, in sharp contrast to modern passband tuning circuits, no additional RF conversion stage is required. With no additional mixing, there is no chance for additional distortion products to show up, and all we get are the benefits of the selectivity! Passband tuning was first used on the 75A-4. Its invention should be credited to Gene Senti.

There are two stages of conventional 455 kc. IF amplification. In many modification articles, it is advised to change the value of R46 to 47K, and R50 to 68K to increase IF gain. If this is done, be sure to change R47 to 1 Watt. Be aware that total receiver gain distribution will be affected.

Gene Senti provided deluxe dual detectors as well. Not only is there a tube diode for AM detection, but Ed Andrade's product detector is included for CW and SSB. Its interesting to note that in all of the modification schemes I've read, not once did anyone mention changing the product detector because it works so well as designed.

After the detectors is a dual-diode audio noise limiter, which is adjustable from the front panel and clips on positive and negative peaks. It is effective on AM, but unfortunately it is all but useless on CW and SSB. There were many "fixes" offered over the years, and it was even the subject of a multi-page Collins service bulletin. In short, what they said was that noise pulses are simply stretched out in the selectivity so much that by the time audio limiting is reached, limiting action is ineffective. After catching heat about this problem for several years, Collins released the type 136C-1 noise blanker for the 75A-4. Using a separate 40 Mc. receiver to convert noise impulses to IF blanker pulses, it works OK, but is nearly impossible to find. The blanker was reviewed in QST November,1959, and was also used in the KWM-1 and KWM-2 rigs for ignition noise suppression in vehicles.

Amplified AGC is used in the receiver. A sample of the IF voltage is picked off after the second IF amplifier and fed to an IF AVC amplifier. Following the amplifier is a dual diode. A small DC bias voltage is placed on the detector half to provide delayed AGC action. The second half of the detector tube is used as an IF AGC noise limiter. By clipping the noise pulses before detection, they are prevented from charging the AGC line and reducing gain during the noise pulse duration. In spite of precautions, there are several problems with the AGC, and they will be discussed later.

Instead of the RF gain control being a simple voltage divider across the AGC bias line, a separate bias rectifier and a "gain gate" was added. In the previous designs, changes in the RF gain control setting would not only change the impedance of the AGC line, but also would change the gain distribution in the controlled stages. In the 75A-4, using a separate bias rectifier provides an isolated, low-impedance AGC line, which further minimizes blocking and distortion with strong signals. To visualize its action, a higher impedance line would form a longer time constant with the AGC bypass capacitors. This longer time constant would mean that a controlled stage might be driven into distortion before the AGC could respond to prevent it. The gain gate, the second half of the bias rectifier tube, decouples the RF gain control from the AGC line. This is done so that the receiver's gain distribution is not disturbed by changes in the RF gain adjustment. Gain distribution is critical in keeping all of the controlled stages operating in their linear regions. Changes such as these came directly from the SSB special projects team at Collins, and Gene Senti's insight into what Art Collins would approve of.

To top off the design of this completely new receiver, the audio section was redone. The 6AQ5 single-ended output stage was retained, but it is now driven from a two-stage triode preamp. Both halves of a 12AT7 are used to drive the output tube. To reduce distortion on signal peaks, the 6AQ5 grid bias is taken from a much more elaborate resistive voltage divider network. There is additional RF by-passing, and if all of this wasn't enough, negative feedback was added to further reduce distortion. A sample of the output transformer secondary is picked off, and applied via R71 to the cathode of the first audio preamp, giving roughly 15 dB of inverse feedback. This helps to smooth out the audio response, and to reduce the effect of DC core saturation on audio peaks, common with small audio output transformers. Some modification articles recommend changing R71 to 100K to reduce the feedback, and to load the audio gain pot with a 1 Megohm resistor to further linearize it. I've never found these to be too useful, but they are fun to try.

CONCLUSION

Due to space limitations, there will be one additional installment of this series which will deal with the many modifications published over the years. Hopefully this will serve as a guide to readers wishing to change their receivers.

The 75A-4 was produced until mid-1959, when it was discontinued in favor of the 75S-1. This brought the Collins A-line equipment to an end, in the natural progression of technical development. The intent of this series of articles has been to provide a clear picture of these receivers, and of the times they were produced in. Surely they will stand as some of the classic communications receivers of all time. ER

The Collins 75A-Series Receivers: A Legacy of High Quality

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Part 6: 75A-4 Modification Summary

75A-4 Modifications

If the reader is looking for a set of step-by-step instructions on how to do a 75A-4 'hack job', thereby turning it into some cold, dark, solid-state blob, he'd better look elsewhere. Vintage technology certainly does not deserve such crude treatment.

Over the years, there have been many different circuits published dealing with 75A-4 mods. I've tried a lot of them, and they have ranged from worthless to outstanding.

Readers should be aware that the only modification that's really necessary is the AGC and coupling capacitor mod per *ER*, May 1990. The rest of the receiver works just fine as it is. The W2VCZ front end mods listed below make an incredible difference, but without the proper tools, test equipment, and experience I would advise against tearing into a perfectly good 75A-4.

The following is a chronological list of modification articles which have appeared in the magazines over the years. This list is probably not complete, but is the best list that I have:

12/14/55 Collins 75A-4 Service Bulletin #1, 3 pages:
Improving noise limiter action (it really needs it!)
Revise Q-Multiplier
Eliminate random fuse blowing
Keeping RF out of muting circuit
10/15/56 Collins 75A-4 Service Bulletin #2, 10 pages:
"S" meter pot replacements
Hum reduction
Noise limiter modification & long discussion of noise pulses
5/31/57 Collins 75A-4 Service Bulletin #2A, 2 pages
More on "S" meter pots and replacements
9/18/57 Collins 75A-4 Service Bulletin #3, 1 page:
Elimination of RF pickup in standby
(I don't know if there are more Collins bulletins than these.)

QST, 5/58, p.76: Audio Muting for 75A-4
Ok, if you need to do it.
QST, June 1959, p.60: Panadapter Connection for 75A-4
CQ, April 1960, p.32: 20 Kc Filter Adapter and SSB IF Noise Limiter
(adds new 20-Kc IF strip for selectivity)
CQ, June 1960, p. 81: 75A-4 Modifications
Change 2nd mixer to 6U8A.

QST, June 1960, p.16: 75A-4 IF Noise Limiter
An SSB pulse clipper that works!
CQ, June 1960, p.42: An SSB IF Noise Limiter (using a 75A-4)
CQ, November 1960, p.62: Addendum to the 6/60 CQ article

CQ, November 1962, p.77: Update The 75A-4
12AT7 first mixer, 6U8A second mixer.
Short article, not much explanation of mods
CQ, May 1963, p.60: 75A-4 Receiver Improvements
6BZ6 RF amplifier and 6U8 2nd mixer mods. Short article.
QST, May 1963, p.55: Improving the CW Selectivity of the Collins 75A-4
Plug-in 500-cycle crystal filter mod for CW. Good article.
QST, July 1964, p.18: 7360 Mixers in 75A-4
Classic article on beam-deflection mixers in 75A-4. See comments below.
CQ, June 1965: Improving the 75A-4 on SSB
Dual-Triode 1st mixer, 6U8 second mixer, various AGC mods.
QST, November 1966, p. 53: Station Design for DX
Gives a short listing of the more popular A-4 mods of the time.
Be careful, some of these are goofy, such as drilling holes in the receiver bottom plate to compensate for dried out lube in the PTO.
CQ, July 1967, p.22: A 2.1 Kc Filter for the 75A-4
Inexpensive Lafayette mechanical filter for A-4.
W2VCZ, October 1967: 75A-4 Conversion Schematic (publication unknown)
This is the circuitry preferred by almost everyone. See comments.
Ham Radio, April 1970: Improving Overload Response in the 75A-4 Receiver.
Very complete, well- written article, with measurements and adjustments. Changes first and second mixers to greatly improve dynamic range.
Ham Radio, January 1971, p. 67: 75A-4 Modifications
Weak article describing various problems and changes.
Ham Radio, April 1972, p. 68: 75A-4 Hints
Cal. oscillator mods.
73 Magazine, April 1972, p. 68 75A-4 AVC modifications
Questionable value.
73 Magazine, February 1973, p.105: Economy Filters for the 75A-4
Plug-in 500-cycle mech. filter and L-C 6 Kc. AM filter mods.
Ham Radio, December 1974, p. 24: Making Your Collins 75A-4 Perform Like New
Excellent article by Bill Orr, W6SAI, on PTO maintenance.
Ham Radio, September 1975, p. 58: 300-cycle crystal filter for Collins Receivers.
OK article, but the filter is now hard to find.
Ham Radio, September 1975, p. 63: Collins 75A-4 Mods
Good, short summary of what works for DX'ers, by W9KNI.
Ham Radio, November 1975, p. 70: Increased Selectivity for Collins 75A-4
Short article by Jim Fisk (W1DTY) to replace IF transformer with 2.1 Kc filter. Also some minor info on resistor changes.
Ham Radio, April 1976, p. 43: 75A-4 Noise Limiter Noise
How to disable 6AL5 noise limiter. Not much good.
QST, August 1978, H&K: Collins 75A-4 Oscillator Dropout
Worth looking up. Good tips and some factory-advised checks.
Electric Radio Magazine, May 1990, K7CMS: Collins 75A-4 Modifications
The best AGC mod ever published; in use at NØDMS. Gives the 75A-4 the same fast-attack and slow-decay characteristic as imported rigs have, and reduces distortion.

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If you intend to use your 75A-4 on a regular basis, and not just look at it on a shelf, then the AGC circuit should be modified. On a stock receiver, the attack time is way too long, which allows the front end to go into distortion before the AGC can respond to prevent it. Also, the decay time is too short, which causes distortion between characters on CW and SSB. Switching from "standby" to "receive" charges up the AGC line and blocks the receiver momentarily, which is very irritating. The *ER* mods by K7CMS will take care of these problems. In addition to them, I use 5 Meg at R92 because I prefer a "slow" decay time of about one second.

The other common problem with 75A-4 performance is crossmodulation, or the transfer of modulation from a strong, unwanted signal onto a weaker desired signal. It is most noticeable on CW and occurs directly in the first mixer. There are several easy ways to get rid of it.

Before changing anything, the first step is to check every capacitor in the receiver for leakage. While this is a lot of time-consuming work, it will pay off later by elimination of strange and/or intermittent troubles.

I've heard a lot of questions on the air regarding the use of 7360 beam-deflection mixers in the 75A-4, specifically referring to the July, 1964, *QST* article. This modification has been evaluated at NØDMS.

The irony of beam deflection tubes is that they were introduced too late in the game to compete with solid-state devices, and at a time when the tube industry was running largely on momentum. (The integrated circuit was invented in 1959.) These are "really neat tubes" and most of them were experimentally developed to serve as color demodulators in TV receivers in the late 1950s. The 7360, unlike the rest, was supposed to be a balanced modulator in SSB transmitters. Its technical debut was in July, 1960 issue of the *RCA Review*, in an article by M.B. Knight, a research engineer working in the Receiving Tube Advances Development Department at RCA, Harrison, N.J. High performance, balanced beam deflection receiver circuits could have been perfected without much additional work, but the end of the hollow state era came instead. By 1964, the higher performance, lower cost, and extremely linear 6JH8 had been released. Properly applied, this tube could have given FET mixers a real run for their silicon. 6JH8 performance indicators were largely ignored in the industry, and they saw very limited use before the end came. The 6JH8 does require higher electrode voltages than most typical receivers can supply, making a retrofit difficult.

If contemplating the July, 1960 *QST* mod, readers should expect "sticker shock" when looking up the price of a new 7360. It is a difficult mod to make, with the additional components and adjustments that are required. It should be realized that in this design, the first mixer is not balanced, as you might hope. The author merely switches the second 7360 plate to ground at the rate of the 1st crystal oscillator. What he ends up with is a low-noise, linear pentode mixer with way too much conversion gain. It does eliminate front-end crossmodulation, but there are better and cheaper ways to do this. In his design for the 2nd mixer, I found further problems. He uses the mechanical filter's input transducer in an attempt to balance the signal plates with respect to ground, and recommends adding a 50 uuF trimmer from one plate to ground "if needed" to improve balance. Examining the mixer output with an analyzer, I found that 35 dB of signal imbalance was the best that it got. As built, I could see both RF and oscillator signal in the mixer output. Using both of these 7360 mixers increased overall gain so much that the filters were overloaded, and they were producing spurious signals of their own due to internal distortion. The Q-multiplier was also overloaded, and the notch was reduced to only 20 dB or so. Noise in the receiver was

greatly reduced, which was nice, but there was so much gain that I could hear light dimmers miles away! Needless to say, these mixers didn't last long in my receiver.

The front end mods which I kept in my receiver were adapted from W2VCZ. I made a few changes from his original design, which will be discussed. (These mods give even higher performance than the ones from April, 1970 *Ham Radio*, which would be my second recommendation.) When I first completed them, I thought I'd made some mistake, because the receiver was so quiet. I started tuning around, using a piece of short wire for an antenna. The first station I came across was using a low wire dipole in Italy, and he was loud. On CW, the only signals detected are the ones in the IF passband. The crossmodulation is completely cured. The third-order 2-tone dynamic range improved to 117.5 dB, and the single-tone blocking improved to 110 dB. This is truly spectacular performance.

I don't have a step-by-step procedure available, as most of the work is straightforward. Try to follow the original component layout as far as possible, and pay attention to original lead dress, especially around the mixers.

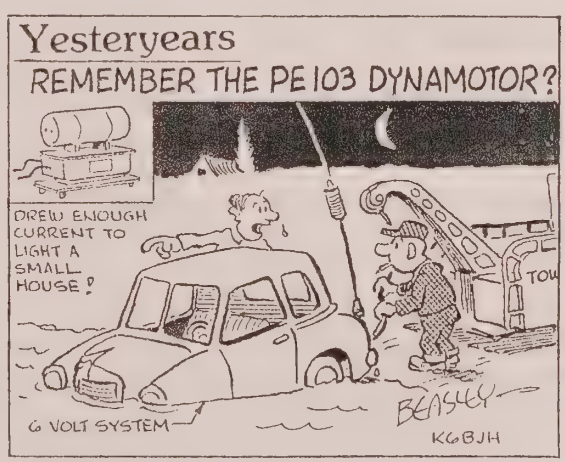
According to figure #1, W2VCZ has replaced the 6DC6 RF amplifier with a type 6GM6. The 6GM6 is a nice front end tube, as it has a more remote cutoff characteristic than the 6DC6, which means it is less likely to be driven into distortion. Its equivalent noise resistance (ENR) is only 447 ohms, 4 times quieter than the 6DC6. The bias needs to be adjusted to provide about -.1 volt with no signal applied, and that's the reason for the 3.3 meg resistors used in the grid circuit. Adding to W2VCZ's design, I have removed C20, and substituted a miniature 10 uH choke in series with the AGC line at pin 1. This was done to provide an even faster AGC response. It further lowers the impedance of the AGC line, but still allows for RF filtering of the AGC line, formerly performed by C20.

There is additional filtering, consisting of a 10 uH choke and a .003-uF condenser in the heater circuits of all the tubes preceding the detector. These were installed after an analyzer across the heater line revealed a terrific amount of intermittent and/or spurious trash, high-level power line harmonics, etc., coming in that way.

W2VCZ used a 6DJ8 twin-triode first mixer. This is an excellent design, with the first section serving as a cathode follower to feed RF voltage into the cathode of the second section. The cathode follower buffers the mixer's RF input against gain changes in the RF stage, and also provides a 50 ohm RF source for the mixer's cathode. LO injection is at the second triode's grid. For this design to work properly, the mutual conductance of the second section must be held down by reducing the plate voltage at the second plate.

Instead of W2VCZ's 6DJ8, I use a 6ES8 as the first mixer. This is a high-performance, frame-grid, low-noise tube, and was designed to be used in premium AGC-controlled TV tuners. At 160 ohms of ENR, it is 8 times quieter than the 6DJ8. It is about the only remote-cutoff triode I know about, and is very hard to overload. It has a cross-modulation factor of just 1% at cutoff with an input signal of 1/2 volt!

continued next page



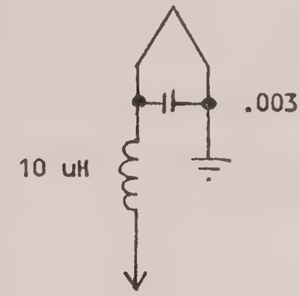
NEW ZEALAND WAS COMING IN, I HIT THE MIC BUTTON, THE HEADLIGHTS DIMMED AND I COULDN'T SEE THE ROAD!

If you use it, try to get the Amperex variety, as they are the PQ (Premium Quality) types with low-resistance, gold-plated pins. There is a high-isolation internal shield; be sure to connect it directly to chassis ground at the tube socket with the shortest possible leads. Try to get the plate voltages close to what is shown, as I optimized them for minimum distortion with a 2-tone RF input.

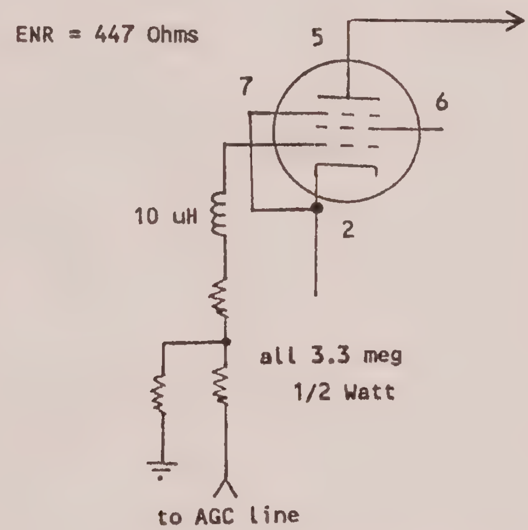
A 6EA8 is called out at the second mixer by W2VCZ. This is the best possible choice I could find, working better than the 6U8 pentode designs published elsewhere. To take full advantage of the low-noise resistance of this tube, a low noise oscillator injection system is needed as well, and it should have a source impedance close to 50 ohms for injection at the 6EA8 cathode. The most troublesome noise in injection oscillators is the broadband "white noise", which can mix to produce spurious signals of its own, also known as "noise modulation". That's the reason for the filter I've added in the LO injection line. The filter is a simple parallel-tuned IF trap. The other change I made was to put 123 volts on the 6EA8 screen. This is an optimum value which gave the lowest value of 3rd-order IMD response. Adjust the value of the 100K series resistor as necessary to get this voltage. The exact value of the resistor will be different from one receiver to another.

I've shown all of W2VCZ's modifications in the drawing. I don't use solid-state rectifiers in my rig.

I'm sure you will like the clean-sounding, rebuilt 75A-4. Its a real pleasure listening to a truly clean receiver, which is free of synthesizer and display noise. Side-by-side comparisons with modern rigs have shown the superior signal-to-noise ratio available with the modified 75A-4 to be a great advantage, especially at a relatively modest station. <u>ER</u>



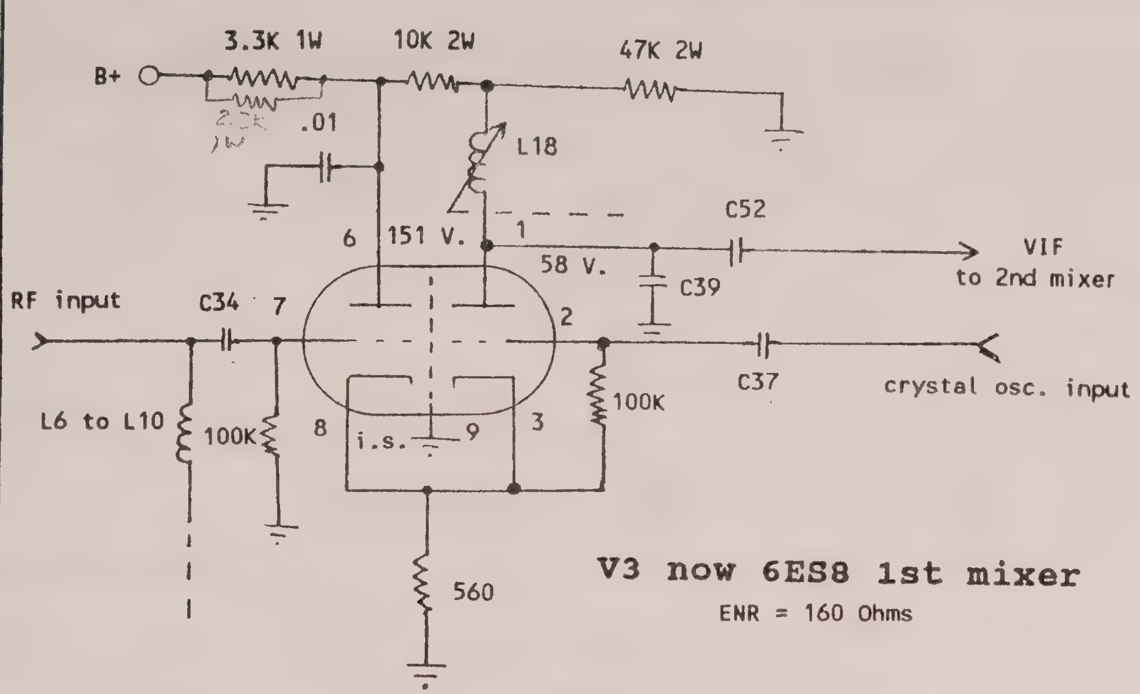
Heater wiring changes



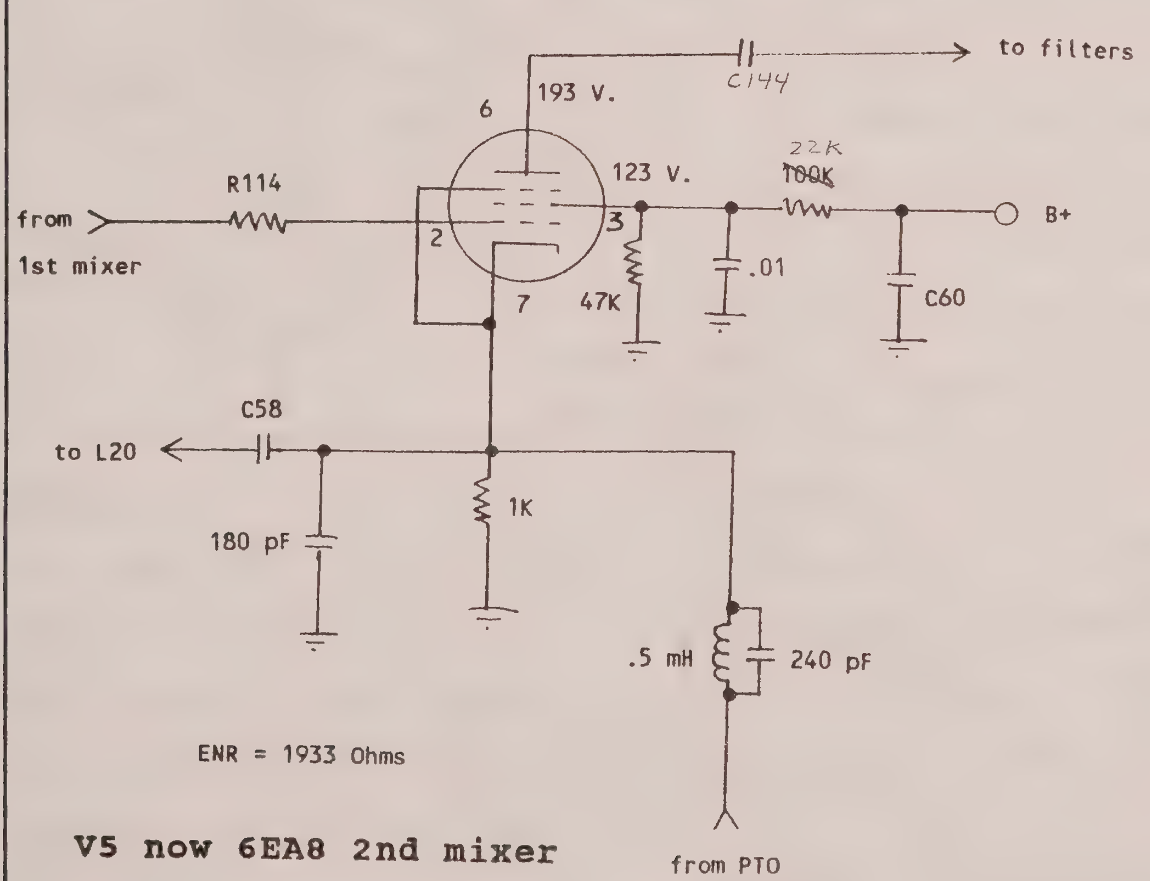
V2 now 6GM6 RF amplifier

OTHER CHANGES:
Remove: R46-R29 in IF stages (see comments)
Add: Silicon diodes in place of 5Y3GT
200 Ohm/10 Watt resistor in C.T. of power transformer
Ground BFO coupling shaft to chassis
R98 to 1 Meg for improved muting
R30 to 56K/2W 1st IF amp screen (see comments)
C112 to .15 uF (AGC time constant)
C101 to .047 (audio coupling)

SPECS per W2VCZ:
noise figure = 4.8 dB at 14.3 Mc.
Sensitivity = .1 uV for 10 dB quieting

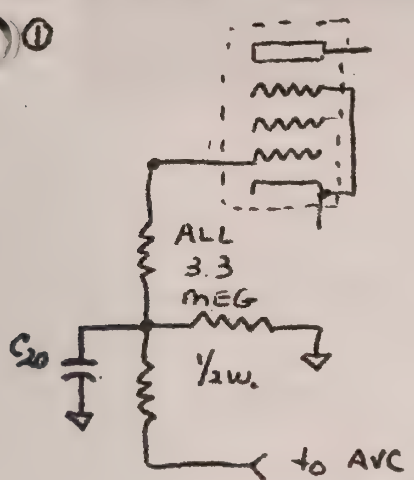


"MODIFIED" W2VCZ 75A-4 MODIFICATIONS Figure



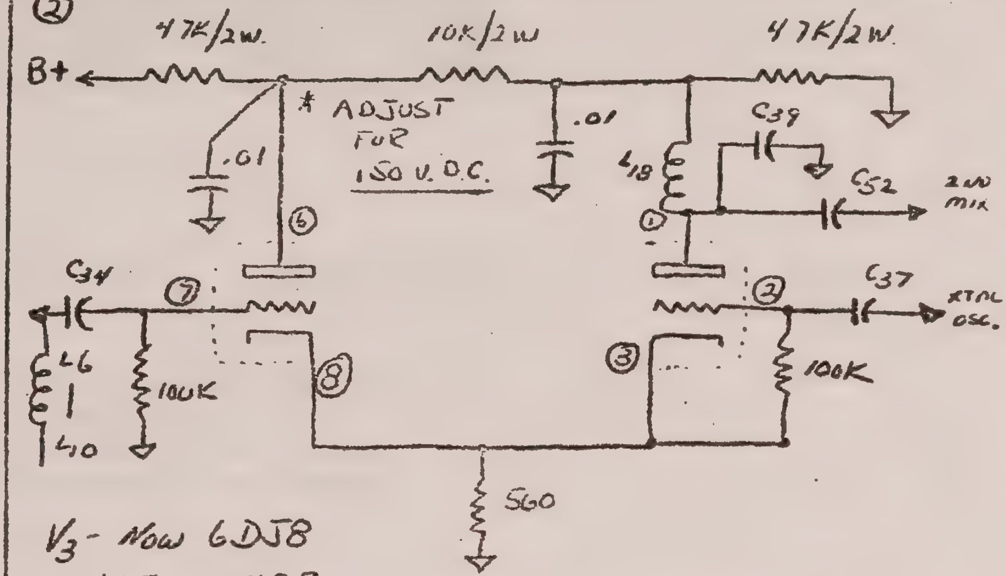
75-A-4 Conversion Schematic: by W2VCZ

①



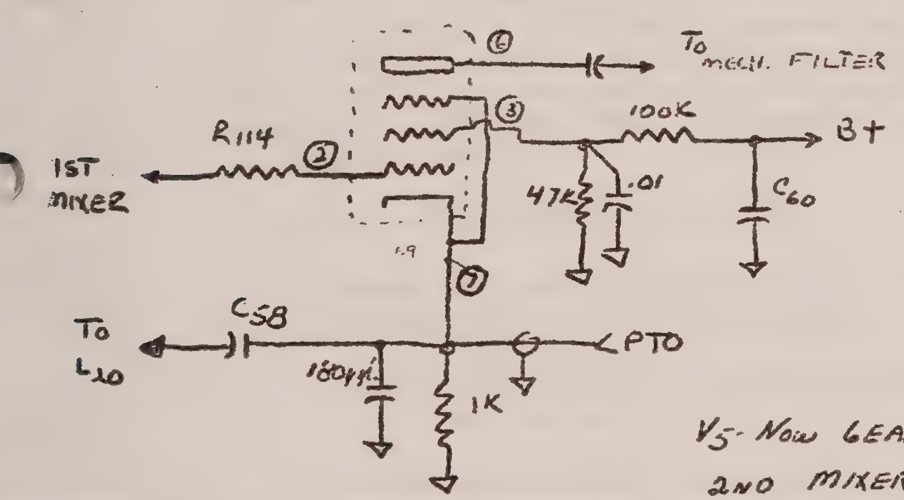
V_2 - Now 6GM6
1ST RF STAGE

②



V_3 - Now 6DJ8
1ST MIXER

③



V_5 - Now 6EA8
2ND MIXER

④ **REMOVE:**

R_{46} - R_{29} - I.F. STAGES

ADD:

GROUND B.F.O COUPLING:
200 OHM/10W. RESISTOR IN C.T. OF PWR TRANSF. —
SILICONE DIODES IN PLACE OF 5Y3 GT.

⑤ **MINOR CHANGES:**

- R_{98} to 1 MEG. FOR IMPROVED MUTING:
- R_{97} - FOR GAIN ADJUST.
- C_{112} - A.V.C. CIRCUIT. NOW - .015 μf.
- C_{101} - A.F. - CIRCUIT - NOW - .047
- ADD - .01/ DISCS 4 OHM + 500 OHM to GROUND.
- R_{130} - 56K/2W - 1ST IF Amp.

⑥ **SPECS.:**

- Noise figure = 4.8db - 14.3mcs
- Sensitivity = .1μv. FOR 10DB quieting
- S'meter = 100μV = 9 +20 - 14.3mcs.
- Calibration - ± 500 cycles

MODIFIED: Oct 24TH 1967

CHECKED. Bob W2VCZ

COLLINS RADIO COMPANY
Field Service Department *Cedar Rapids, Iowa*

COLLINS SERVICE BULLETIN

EQUIPMENT TYPE: 75A-4 RECEIVER SERVICE BULLETIN NO. 1 12-14-55

SUBJECT: A. Improve Noise Limiter Operation
B. Revise Q Multiplier
C. Eliminate Random Fuse Blowing
D. Keep RF out of Muting Circuit

A. Improve Noise Limiter Operation

Due to variations in contact potentials of various 6AL5's, there has been trouble in consistantly meeting the specification limit of 40DB limiting of CW. The addition of certain resistors to balance out the contact potential of V12 has eliminated the problem. If trouble is noticed with the noise limiter this revision is recommended; however, if no trouble has been noticed this revision is not suggested. The replacement of V12 may cause this problem and in that case the modification should be made.

Procedure for modification:

1. Remove all wires from ground end of R67 and place them on convenient grounding points of S4.
2. Connect R115, 1200 ohm 1/2 watt resistor, between ground end of R67 and ground on S4.
3. Add R116, 100K ohm 1 watt resistor, between C94B and nearest unused tie point.
4. One wire must be added to the front panel cable in order to connect R116 to the junction of R115 and R67.

Additional Parts Required:

Qty.	Description	Part Number
1	1200 ohm 1/2 watt ± 10% Resistor	745 1356 00
1	100K ohm 1 watt ± 10% Resistor	745 3436 00

B. Revise Q Multiplier

This change was made in order to allow production to meet our 40DB rejection notch. This modification should not be made unless the Q multiplier notch cannot be set as described below.

1. Tune in 1800 KC calibration signal with KILOCYCLES dial to exact center of passband by watching the "S" meter.

*2. Adjust ANT TRIM until "S" meter reading of S9/40 is obtained.

3. Turn R-36 to full counterclockwise position.

4. Turn rejection tuning control (C-72) to center of passband.

5. Adjust L-26 for minimum "S" meter reading.

6. Turn R-36 clockwise until an "S" meter reading is obtained.

7. Recheck steps 4 and 5, readjust where necessary.

If difficulty in the final adjustment of L-26 is encountered, the REJECTION TUNING control may be moved slightly to compensate for small errors in L-26.

A rejection notch which is deeper than S-7 may be obtained with a higher setting of R36. This is not advisable; however, because of the resulting instability such as hum modulation and a tendency for the "Q" multiplier circuit to lock to a strong interfering signal.

The effect is quite similar to that obtained by operating a regenerative receiver too near to the edge of oscillation.

As R-36 is advanced even further clockwise, the "Q" multiplier circuit will oscillate. This causes the depth of the rejection notch to decrease sharply as R-36 is rotated through the point where oscillation begins.

*If it is not possible to adjust to exactly S-9/40, try another check point, or use a signal generator.

Procedure for modification:

1. Change V7 to 12AX7.
2. Delete R108.
3. Change R32 to 680 ohm.
4. Change R42 to 68 ohm.
5. Change R35 to 30K ohm.
6. Ground Center Pin of V7 Socket.

Additional Parts Required:

Qty.	Description	Part Number
1	12AX7 tube	255 0201 00
1	680 ohm 1/2 Watt ± 10% Resistor	745 1345 00
1	68 ohm 1/2 Watt ± 10% Resistor	745 1303 00
1	30K ohm 1/2 Watt 1% Resistor	705 2166 00

C. Eliminate Random Fuse Blowing

To eliminate random fuse blowing, F1 fuse has been changed from the standard 2 amp fuse to a 2 amp slow blow fuse part number 264 0297 00.

Part Required:

Qty.	Description	Part Number
1	2 AMP Slow Blow Fuse	264 0297 00

D. Keep RF Out of Muting Circuit

To eliminate the possibility of getting RF into the Muting circuit, a capacitor C141, .01 uf part number 913 1188 00, has been added between terminals M and G of E3. Serial Number effectivity 450 and above.

Part Required:

Qty.	Description	Part Number
1	.01 mf Capacitor	913 1188 00

For modification parts, price quotations (minimum order charge is $15.00), and availability contact Collins Radio Company, Service Parts Department, Cedar Rapids, Iowa 52406. All parts orders must specify the Collins modification kit number, or part numbers, quantity required, and reference this service bulletin.

COLLINS RADIO COMPANY

Field Service Department Cedar Rapids, Iowa

COLLINS SERVICE BULLETIN

EQUIPMENT TYPE 75A-4 RECEIVER SERVICE BULLETIN NO. 2 DATE 10-15-56

SUBJECT: A. "S" METER SENSITIVITY POTENTIOMETER REPLACEMENT
B. MODIFICATION TO REDUCE HUM IN 75A-4
C. NOISE LIMITER MODIFICATION

SUBJECT A

"S" METER SENSITIVITY POTENTIOMETER REPLACEMENT

In the event that replacement of R41, "S" Meter SENS adjust potentiometer, becomes necessary, a new type CPN 377-0122-00, is recommended. The original potentiometer had an insulated rotor contact. The replacement potentiometer has a grounded rotor and must be insulated from the chassis. The following procedure is recommended where the replacement of R41 is necessary.

1. Mount the potentiometer, 100 ohm CPN 377-0122-00, to the two phenolic standoffs, CPN 500 8921 00, using two phillister head screws, CPN 347 0168 00. Place a solder lug, CPN 304 4200 00, under one of the mounting screws.

2. Remove old R41 from the chassis and mount the assembly of Step 1 above in its place, fastening with two 6-32 X ¼ binder head screws, CPN 343 0328 00.

3. Connect wire with orange and blue tracers to the terminal of the potentiometer.

4. Connect two wires with orange and green tracers to solder lug fastened to frame of potentiometer.

Additional parts required: Modification kit 542 0849 00

Qty	Description	Circuit Symbol	Collins Part Number
1	Resistor, Variable 100 ohm	R41	377 0122 00
2	Posts, Phenolic		500 8921 00
2	Screws, 6-32 X ¼ Phillister head		347 0168 00
2	Screws, 6-32 X ¼ Binder head		343 0328 00
1	Lug, Solder		304 4200 00

SUBJECT B
MODIFICATION TO REDUCE HUM IN 75A-4

An investigation of the hum present in the 75A-4 has shown that the four leads from the power transformer (T6) to the rectifier tube (V17) seem to be coupling rectified pulses into the circuitry of the BFO (V20). Shielding of these wires eliminate these pulses from the BFO circuitry.

In addition, the lead from the arm of the audio gain control R62 to pin 2 of V13 is tied in the cable in the audio chassis and is picking up some hum. Rerouting of this lead and the use of a shielded lead reduces this hum pick up.

Production units with serial numbers above 2715 incorporate these modifications. The following procedure is recommended for use on receivers with lower serial numbers which will substantially reduce the amount of hum present in the receiver. Refer to Figure 2.

1. Remove bottom cover from chassis.
2. Remove front panel from chassis.
3. Remove the yellow wires from V17 pins 2 and 8.
4. Remove the red wires from V17 pins 4 and 6.
5. Insert four wires removed in Step 3 and 4 above into shielding, CPN 425 0040 00.
6. Ground each end of shielding.
7. Resolder yellow wires to pins 2 and 8 of V17.
8. Resolder red wires to pins 4 and 6 of V17.
9. Unsolder wire from center contact of AF Gain, R62, on front panel. Tape this wire on to cabling.
10. Unsolder wire from pin 2 of V13 and tape this wire on to cabling.
11. After inserting shielded wire, CPN 439 7907 00 into sleeving, CPN 152 1312 00, connect this wire from center contact of R62 to pin 2 of V13. Route this wire as shown in Figure 2.

Additional parts required: Modification kit 542 0851 00 -

Qty	Description	Collins Part Number
0.6	Shielding (FT.)	425 0040 00
2	Wire, Shielded (FT.)	439 7907 00
1.8	Sleeving (FT.)	152 1312 00

SUBJECT C
NOISE LIMITER MODIFICATION

Recent research on the general subject of noise limiters and in particular on the noise limiter circuit used in the 75A-4 has prompted a modification to this circuit. The capacitors C147 and C148 were added to change the audio response characteristics of the receiver to a more desirable shape. They reduce the high frequency response and eliminate most of the high frequency components encountered in the pulse type noise. An additional section of filtering in the noise limiter bias supply has been incorporated to prevent any pulses that may appear on the AVC line and/or bias supply from feeding back through the noise limiter (V12). The bypass capacitors of both sections of this filter are now returned to the high side of a resistor (R118) which has been added to the AM detector circuit. This feeds a small amount of the pulses detected in the AM position to the cathode of the noise limiter. However, these pulses are out of phase with the pulses coming in on the plate and therefore help cancel out the pulses going through the noise limiter.

A noise pulse, when generated, is usually of a high amplitude and short time duration. This means that it contains many harmonics, or could be said to have a very wide bandwidth. So when a noise pulse is fed through a highly selective tuned circuit or a mechanical filter, only a certain portion of the original frequencies will come through This has the effect of making a low amplitude and long time duration pulse out of what was originally a high amplitude and short time duration pulse. This means that even with the best limiter available it is sometimes very difficult to obtain much limiting action without also limiting the desired signal.

A very good explanation of this effect was given in an article by George Grammer, WIDF, in the May 1946 issue of QTS magazine. We quote a portion of that article to help clarify the explanation of the effect of selectivity on noise pulses.

NOISE PULSES AND SELECTIVITY

> Fig. 1 gives a qualitative picture of noise and signal, but is by no means accurate in a quantitative sense when the circuit in which the oscillations exist is an IF amplifier operating in the vicinity of 450 kc. The number of cycles in the damped oscillation -- and therefore the length of time the oscillation persists, since the frequency is fixed -- is primarily a function of the Q of the circuit; the higher the Q the larger the number of cycles before the oscillation amplitude decays to a given fraction of the maximum amplitude. The normal 456 kc IF amplifier has an effective Q of such magnitude that even when excited by a signal pulse, several hundred cycles will occur before the amplitude dies down to a 1 per cent of its maximum value. <u>Since Q and selectivity are directly related, an increase in selectivity brings with it an increase in the time required for damped oscillations to die down. This has an important bearing on noise reduction.</u>
>
> The noise that remains after full clipping will interfere to the extent that it tends to wipe out part of the beat note, and this in turn is a

function of the length of time during which the noise exists. If the noise pulse is very short it may wipe out only a cycle or two of a beat frequency which usually lies between 500 and 1000 cycles per second, and the loss of one or two cycles is not likely to be noticed. On the other hand, if the time duration of the noise pulse is great enough the signal may be unreadable even though the maximum noise amplitude is limited to that of the signal. Since the time duration of the r-f noise oscillations increases with the selectivity of the IF amplifier, the rectified envelope of the noise pulse likewise lasts longer, and the effectiveness of a limiter decreases when the receiver selectivity is increased.

The seriousness of pulse lengthening depends upon the original strength of the pulse and the rate of pulse recurrence. The stronger the pulse the longer the time required for the amplitude to die down to a fixed level, and if the pulses occur in rapid succession they may even overlap when lengthened out by selectivity. The rate of recurrence of most noises seems to be in the neighborhood of 120 per second (many noises are associated with the power-line frequency) so the time during which the noise pulse amplitude is comparable to that of the desired signal has to be held to considerably less than 1/120th second if limiting is to do any good.

The effect of selectivity on the shape of noise pulses can be observed quite readily on an oscilloscope if a recurrent pulse is available for examination. Fig. 4 shows progressively increasing selectivity from normal IF to the maximum available with a crystal filter. Note that the selectivity reduces the maximum amplitude in addition to increasing the time duration. It is entirely possible for the maximum pulse amplitude to be reduced to such an extent that it does not exceed the amplitude of the desired signal--in which event, although limiting is useless, there is nevertheless an improvement in the signal-to-noise ratio. The effect is readily observable by switching a crystal filter in and out when there is ignition noise of moderate strength; it usually makes the difference between copying and not copying a weak signal. Yet with normal IF selectivity and a good limiter it would be possible to clip the noise pulses so effectively they would not even be heard. It would be easy to interpret this last statement to mean that high selectivity is somewhat of a handicap in the presence of impulse noise, but despite the fact that there are occasions when it becomes possible to copy a signal with normal IF selectivity, plus limiting, and impossible to copy the same signal through a crystal filter, it would not pay to jump to such a conclusion.

CONTINUOUS NOISE

In the final analysis all noise is of a pulse-like nature, but when the pulses are random and occur so frequently that they overlap even though they are of extremely short duration, the result is a hiss-like noise of more or less uniform average intensity. This is the familiar receiver hiss, much of it generated in the circuits and tubes, but some of it similarly random noise picked up by the

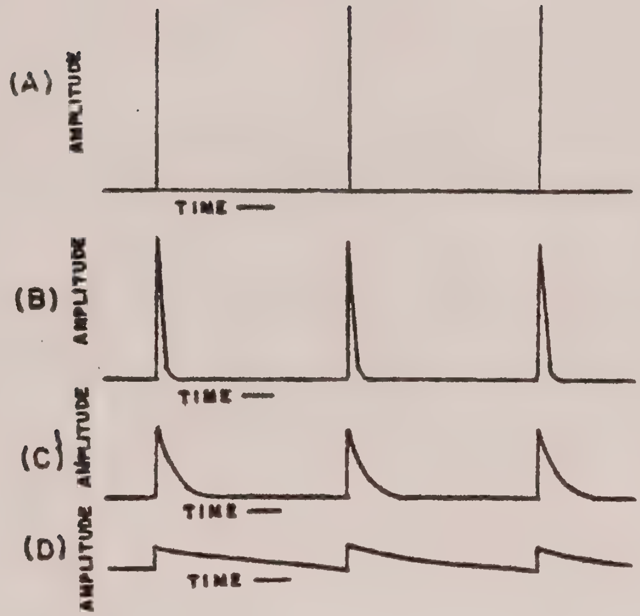


Fig. 4—Effect of increasing selectivity on the shape of noise pulses. (A) shows the pulse as it might appear with normal i.f. selectivity, (B) with a broad crystal filter, (C) and (D) with progressively increasing selectivity. These drawings, although not to true amplitude scale, shows the effect of high selectivity in decreasing the amplitude of a pulse. They were made from oscilloscope patterns using a loran signal, the pulse intervals being approximately 1/16th second. With maximum selectivity (D) most of the pulse interval is required for the pulse amplitude to decrease to a negligible value.

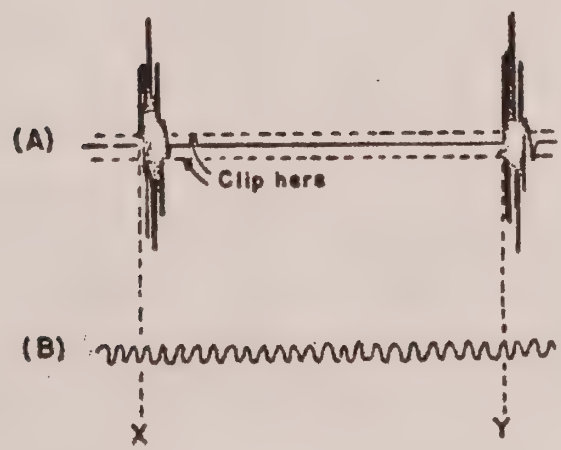


Fig. 1—Representation of noise impulses compared with a continuous carrier.

antenna. The energy distribution does not exist in short, high-amplitude bursts with relatively long silent periods between; it is continuous in time and there is no sense in expecting a limiter to reduce it.

On the other hand, this is the very type of noise that is reduced by increased selectivity; it is spread out over the whole frequency spectrum and the higher the selectivity the smaller the amount of it that is passed out by the selective circuits. Weak signals that are unreadable in the hiss noise with normal IF selectivity become readable with a crystal filter because the selectivity reduces the noise without changing the signal strength. When impulse noise is added to the hiss it may or may not be possible to copy a signal through the filter, but it certainly will not be possible without it even though the limiter does a perfect job of taking out the noise impulses. However, if the signal can be copied through the hiss with normal IF selectivity a good limiter usually will prevent impulse noise from interfering; whether or not the same signal can be copied with the crystal filter is a matter of the amplitude and character of the noise and the degree of selectivity. Ultimately, the noise pulses passing through the filter may result in a continuous "ringing" through which no signal can be copied, simply because the pulses are of such amplitude and have been lengthened to such an extent that they overlap to produce what is practically a continuous wave. This requires a noise amplitude such that with normal IF selectivity and without limiting, the signal is so deeply buried in noise as to be completely undiscernible to the ear. But if the noise is of the high-amplitude, short-duration character a good limiter will not only make the signal audible but make it perfectly readable.

This makes a convincing demonstration of the usefulness of a noise limiter, but the occasions when it can be done are relatively infrequent. The more common case is the one where the noise amplitude is such that either the crystal or normal-IF-plus-limiter will make the signal readable. With the filter, the limiter gets only an occasional chance to work because the noise amplitude is reduced by the selectivity; the result is that the impulse noise is there even though it may not prevent making perfect copy. With the normal-IF-plus-limiter the noise may be eliminated almost 100 per cent but the hiss is much stronger and the selectivity against other stations is much reduced. Which is better depends upon the operator's likes and the conditions--noise and other interference--existing at the moment.

There are at least two other types of noise that tend to be continuous and therefore hard to handle with a limiter insofar as increasing signal readability is concerned. One is natural static; if it is stronger than the signal the latter is likely to be blotted out completely for the duration of the crash. The other is associated with some electrical devices in which the sparking appears to be practically continuous during the half of each a-c alternation when the voltage is highest, with the result that for about half the time the noise pulses are

overlapping. When a limiter is applied on such a noise the residue is a throttled-sounding buzz.

The End

Since the effective Q of the mechanical filters used in the 75A-4 is relatively high, it can be seen that a problem with impulse type noise does exist.

We have made some modifications to the noise limiter circuit used in the 75A-4, serial number 2716 and above, and these modifications are described below. While the modification provides somewhat better operation, the basic problem of noise pulses and selectivity should be kept in mind when deciding what to expect from the noise limiter in the 75A-4 or any receiver having highly selective tuned circuits.

Procedure for modification of receivers below serial number 2716.

1. Move all the shields and ground connections from pin 3 of S3 to pin 1 of S4 as shown in Figure 1.

2. Connect pin 9 of S3 to pin 1 of S4.

3. Add 6.8 K ohm resistor, R118, CPN 745 1387 00, from pin 3 of S3 to pin 1 of S4.

4. Mount tie point, CPN 306 0001 00, on mounting screw of C94 as shown in Figure 2.

5. Move the 100K ohm resistor, R116, and the DA9256 wire on TS-1-1 to TS-4-3.

6. Move the DAS96 wire on TS-3-3 to TS-1-1.

7. Add a 47K ohm resistor, R117, CPN 745 1422 00, between TS-3-3 and TS-1-1.

8. Remove the ground end of C97 from ground and tie it to TS-4-2.

9. Add a 0.1 mf capacitor, C146, CPN 931 0299 00, between TS-1-1 and TS-4-2.

10. Add the DA935 wire from TS-4-2 to pin 3 of S3 on the front panel.

11. Add the 510 mmf capacitor, C147, CPN 912 0545 00, from pin 5 of V12 to ground, TS-2-2.

12. Add the 510 mmf capacitor, C148, CPN 912 0545 00, from pin 2 of V12 to ground, TS-3-2.

Additional parts required: Modification kit 542 0850 00 -

Qty	Description	Circuit Symbol	Collins Part Number
1	Tie point	TS-4	306 0001 00
1	Resistor, 6.8K, ½ watt	R118	745 1387 00
1	Resistor, 47K, ¼ watt	R117	745 1422 00
2	Capacitor, 510 mmf	C147, C148	912 0545 00
1	Capacitor, 0.1 mf	C146	931 0299 00

TO OBTAIN PARTS:

For modification parts, price quotations (minimum order charge is $15.00), and availability contact Collins Radio Company, Service Parts Department, Cedar Rapids, Iowa 52406. All parts orders must specify the Collins modification kit number, or part numbers, quantity required, and reference this service bulletin.

FIGURE I

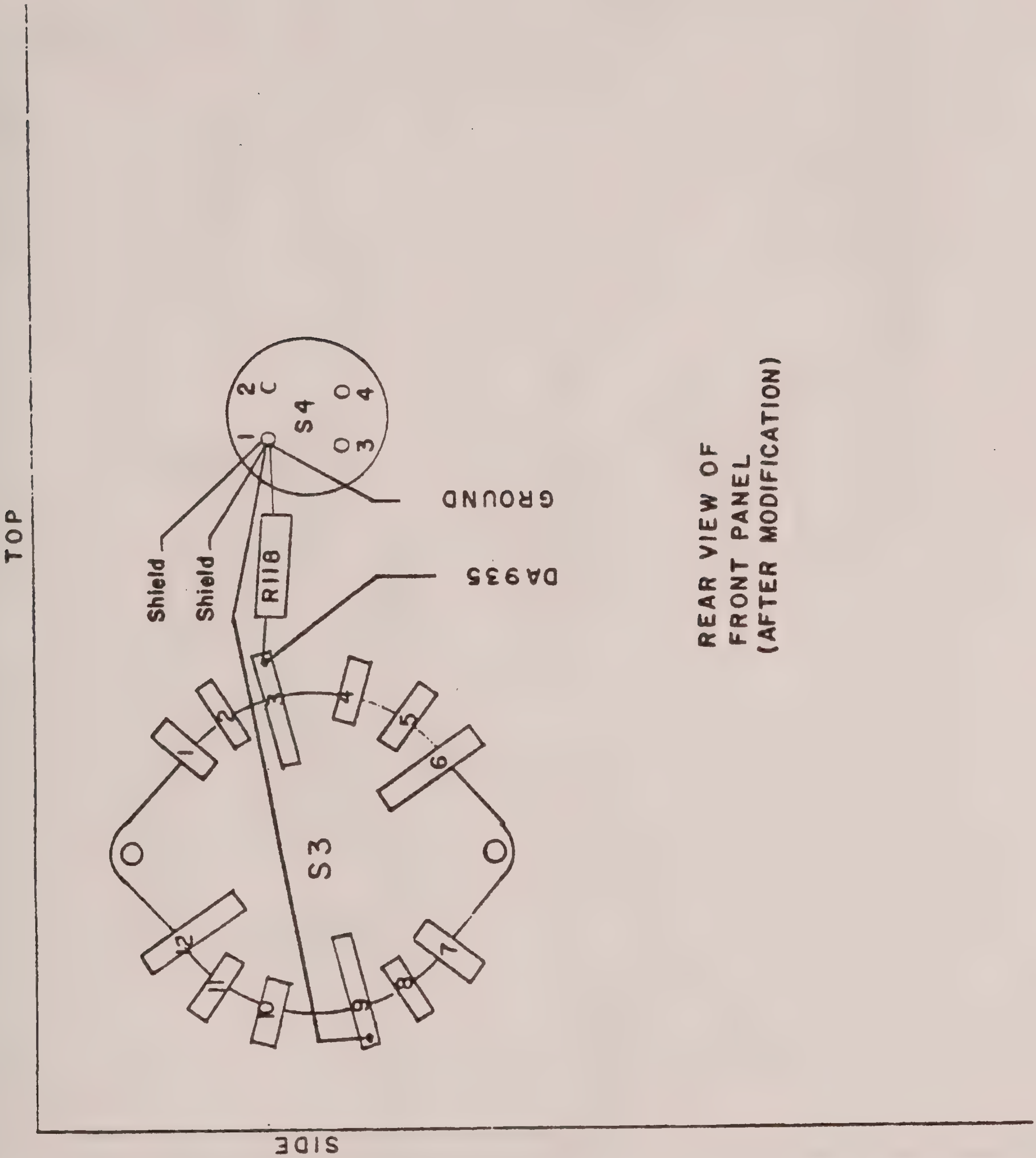
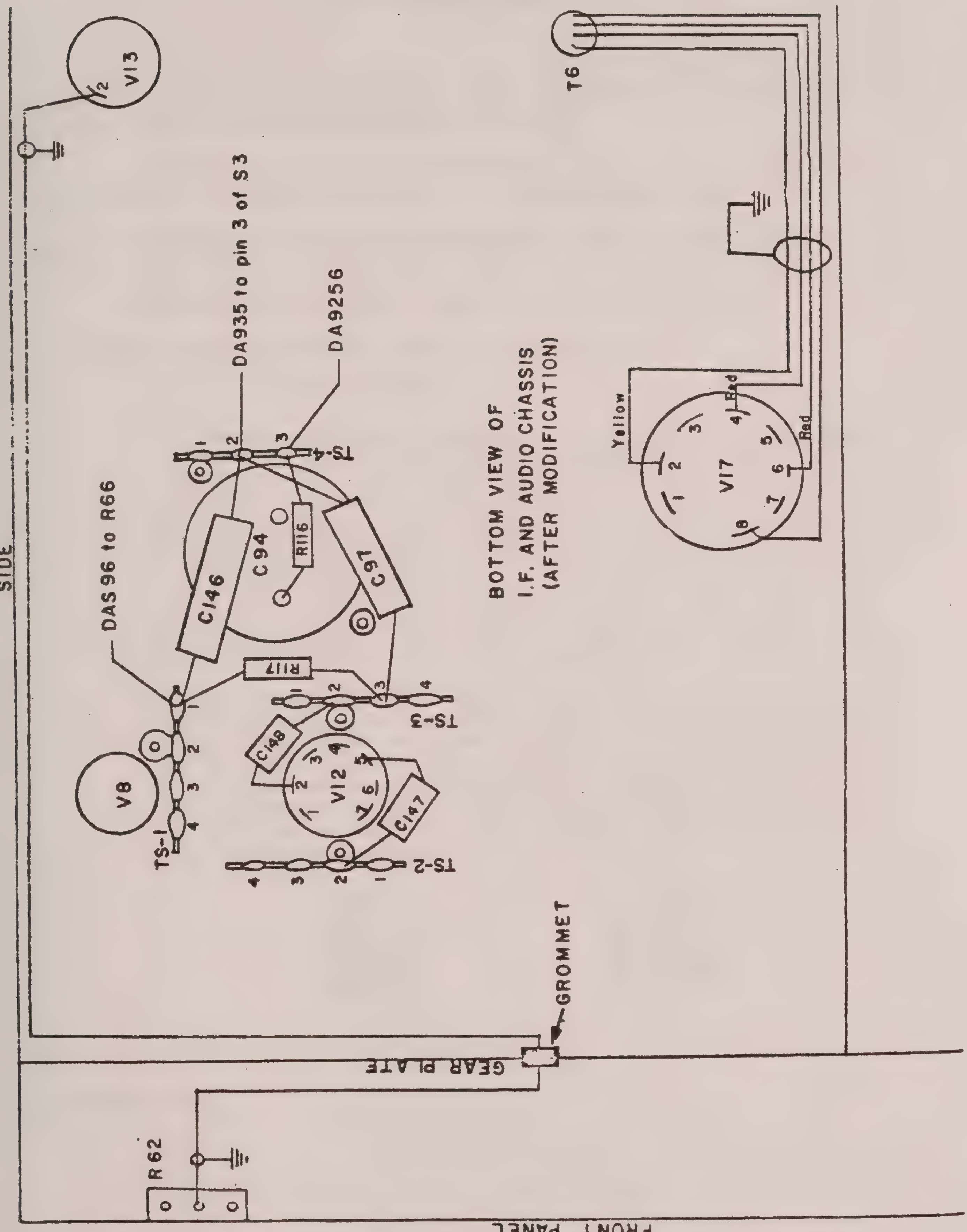

TOP
SIDE
Shield
Shield
R118
GROUND
DA935
S4
S3
REAR VIEW OF
FRONT PANEL
(AFTER MODIFICATION)

FIGURE 2


BOTTOM VIEW OF
I.F. AND AUDIO CHASSIS
(AFTER MODIFICATION)
SIDE
FRONT PANEL
GEAR PLATE
GROMMET
V13
T6
V8
V12
V17
C146
C94
C97
R116
R117
C148
C147
TS-1
TS-2
TS-3
TS-4
R62
DAS96 to R66
DA935 to pin 3 of S3
DA9256
Yellow
Red
Red

75A-4 ADDENDA

(For 520 5052 00 Dated 1 Dec. 1956)

The RF gain control circuit of this receiver has been modified to make use of the unused half of V19 to decouple the RF GAIN control from the AVC line. Change the schematic diagram as follows:

a. Connect pin 7 of V19 to the AVC bus. This can be found by tracing the line from the AVC TEST POINT, J4, to directly above V19.

b. Disconnect the arm of RF GAIN control R99 from the junction of R91, R92, and R93 and connect it to pin 1 of V19.

c. Connect the junction of R91, R92, and R93 to ground.

Paragraph 5 on page 4-4 should read as follows:

5. RF GAIN CONTROL SYSTEM.

The RF gain control system in the 75A-4 works in conjunction with the AVC system. To control the sensitivity of the set, a source of fixed bias is added to the AVC voltage which is then applied to the AVC controlled tubes. This system maintains the gain distribution constant throughout all settings of the gain control. A low impedance type AVC line is employed. In order to prevent the RF GAIN Control from affecting the characteristics of the line due to loading, an RF gain gate is employed to decouple the RF GAIN Control from the AVC line. This gate is in the form of 1/2 of a type 6AL5 twin diode, V19. The other half of the tube is employed as a bias rectifier.

Bias from this bias rectifier is connected to one end of the RF GAIN Control. The arm of the control is connected to the AVC line through the RF gain gate, V19 (pins 1 and 7). Advancing the control adds negative bias to the AVC bias and reduces the gain of the tubes connected to the AVC line, namely, V-2, V-6, V-8, and V-9. The value of R104 is selected in final test and ranges from 270 ohms to 560 ohms. R104 in this set will be one of the following values and part numbers:

270 ohms	745 1328 00
330 ohms	745 1331 00
390 ohms	745 1335 00
470 ohms	745 1338 00
560 ohms	745 1342 00

5 February 1957

75A-4 VFO ADJUSTMENT

The VFO is calibrated at the factory and should require adjustment at only widely separated intervals. If the calibration error becomes excessive for operation or beyond the point where the vernier dial corrector (ZERO SET Control) can correct, the following procedure should be followed to make correcting adjustments:

a. Use the 100 KC/s calibrator. Allow the receiver to warm up from 1 to 2 hours.

b. Set the BAND CHANGE switch to the 160-meter band. Tune KILOCYCLES dial to 1.5 MC/s. Set up in accordance with paragraph 9 of OPERATION section to zero beat with calibrator signal. Note the dial reading if fiducial line cannot be set to 0.

c. Rotate KILOCYCLES dial to 2.5 MC/s and exactly tune until zero beat is obtained. Do not readjust BFO or ZERO SET Control. The calibration error is then the number of dial divisions more or less than the 10 turns it should take to cover the range. Usually, the error tends to be toward more rotation of the KILOCYCLES dial than the 10 turns that should be required. To correct this error, proceed as follows:

(1) Rotate the KILOCYCLES dial towards and through dial zero until a total of 1.8 times the dial division error has been counted. Engage the trimmer adjusting stud with a strong thin wire and turn until zero beat is restored. The ZERO SET adjustment can now be rotated so that the ZERO SET is set to dial zero.

(2) To check the accuracy of the adjustment retune the KILOCYCLES dial to 1.5 MC/s and check the calibration error. If the adjustments have been done carefully less than 1/2 division dial error will be found. The above procedure can be repeated until satisfactory results are obtained. This endpoint adjustment restores factory accuracy to the intermediate points, also.

(3) If it is desired to recenter the dial vernier pointer the following additional procedure should be followed. Set the ZERO SET Control to mid-scale, loosen the two setscrews of the VFO dial-shaft coupler and carefully turn the oscillator shaft until zero beat is obtained. During the VFO adjustment, best results in frequency readings will be obtained if the AVC is OFF and the RF GAIN Control is used at a low value.

COLLINS RADIO COMPANY
Field Service Department *Cedar Rapids, Iowa*

COLLINS SERVICE BULLETIN

SERVICE BULLETIN NO. 2A

EQUIPMENT TYPE: 75A-4

5-31-57

SUBJECT: "S" METER SENSITIVITY POTENTIOMETER AND ZERO POTENTIOMETER REPLACEMENT

Subject A of 75A-4 Service Bulletin No. 2 dated 10-15-56 discussed replacement of the "S" Meter Sensitivity Potentiometer, R41. Subsequent research has proved a more effective improvement of the "S" meter functions can be obtained by replacing both the Sensitivity (R41) and Zero (R43) potentiometers and modifying the related circuits as outlined below. Modification kits 542 0849 00 now include the parts listed below instead of the parts listed in Bulletin No. 2.

Replacement of R41 and R43 involves the following procedure:

1. Remove Meter Sensitivity and Meter Zero potentiometers.
2. Mount 6-32 x 1¼ spacers (540 9225 003) in holes formerly used for mounting zero set and sensitivity potentiometers.
3. Mount potentiometers (750 8081 00) to plate (542 3150 002) and mount this assembly to the spacers.
4. Remove resistor R42.
5. Move resistor R39 as illustrated on installation drawing 542 4452 002.
6. Delete resistor R40 which shunts the meter.
7. Remove from the cable the short wire with orange and green tracers which connects the meter zero potentiometer to the meter sensitivity potentiometer.
8. Connect the wire with orange, green, and blue tracers which formerly went to the hot terminal of the meter sensitivity potentiometer to the clockwise terminal of the new meter sensitivity potentiometer.
9. The meter should be wired as shown in the top view of the front panel on installation drawing 542 4452 002.
10. Rewire the terminal strip adjacent to tube V8 as shown in installation drawing 542 4452 002.

ADDITIONAL PARTS REQUIRED

Modification Kit 542 0849 00, consisting of the following items

QTY.	DESCRIPTION	CIRCUIT SYMBOL	COLLINS PART NUMBER
1	Plate-Pot Mtg.		542 3150 002
2	Post-1¼ Lg.		540 9225 003
2	Resistor-Variable, 500 ohm	R41, R43	750 8081 00
4	Screw-6-32 x ⅜ PBH		343 0169 00
4	Washer-Ext. Lock No. 6		373 8020 00
1	Lug-Solder		304 0318 00
1	Drawing-Installation		542 4452 002
2.0′	DA 9256 wire		439 7060 00
2.0′	DA 95 wire		439 7036 00
1.0′	#20 bus		421 2020 00
0.5′	#20 sleeving		152 1347 00

SERIAL NUMBER EFFECTIVITY:

All production 75A-4 Receivers above serial number 3423 contain the above described modification. A few units below #3423 were also modified before shipment from the factory. Inspection below the chassis will disclose whether a receiver has been modified. If the sensitivity and zero potentiometers are mounted on a small metal plate suspended beneath the chassis, the receiver has been modified.

TO OBTAIN PARTS

Registered owners of receivers which have not been modified, and those whose receivers were modified in accordance with SUBJECT A of 75A-4 Service Bulletin No. 2 dated 10-15-56, may obtain the kit described in this bulletin by ordering Modification Kit 542 0849 00 from Collins Radio Company, Service Parts Department, Cedar Rapids, Iowa.

For modification parts, price quotations (minimum order charge is $15.00), and availability contact Collins Radio Company, Service Parts Department, Cedar Rapids, Iowa 52406. All parts orders must specify the Collins modification kit number, or part numbers, quantity required, and reference this service bulletin.

EQUIPMENT TYPE 75A-4 BULLETIN NO. 3 DATE 9-18-57

SUBJECT: ELIMINATION OF RF PICKUP WHILE IN STANDBY POSITION

For most installations the standby circuit in the 75A-4 Amateur Receiver is entirely satisfactory. However, Collins has received a few reports of customers being unable to completely quiet their 75A-4 while transmitting. It has been found that RF getting into the audio stages of the receiver, through accessory equipment wiring, has generally been the cause of this trouble.

While the problem has not been serious enough to warrant a production revision to the receiver design, the following changes and additions are recommended for instances of this difficulty.

1. Remove the bottom panel from the receiver cabinet to expose the under-chassis wiring.
2. Add a 56 uuf capacitor (912 0477 00) from pin 2 of tube socket XV13 to the common ground return for XV13.
3. Add a 56 uuf capacitor (912 0477 00) from pin 7 of tube socket XV13 to the common ground return for XV13.
4. Add a 100 uuf capacitor (912 0495 00) from pin 7 of tube socket XV22 to the common ground return of XV22.
5. Add a .001 ufd capacitor (913 3009 00) from pin 1 of tube socket XV10 to the common ground return for XV10.
6. Add a solder lug (304 0317 00) under the terminal strip mounting screw nearest terminal "M" of terminal strip E3.
7. Remove grounded end of capacitor C141 from E3 terminal G and reconnect to the solder lug of step 6.
8. Add a solder lug (304 0317 00) under the terminal strip mounting screw nearest terminal "500" of terminal strip E4.
9. Add a .01 ufd capacitor (913 3013 00) from the 4 ohm terminal of terminal strip E4 to the solder lug installed in step 8. Do not solder at lug.
10. Add a .01 ufd capacitor (913 3013 00) from the 500 ohm terminal of terminal strip E4 to the solder lug of step 8. Solder.
11. Replace bottom panel of receiver cabinet.

ADDITIONAL PARTS REQUIRED

QTY.	DESCRIPTION	COLLINS PART NUMBER	UNIT PRICE	TOTAL
2	Capacitor: mica, 56 uuf ±10%, 500 wv	912 0477 00	.17	$ .34
1	Capacitor: mica, 100 uuf ±10%, 500 wv	912 0495 00	.17	.17
1	Capacitor, ceramic disc, .001 ufd, +100—20%, 500 wv	913 3009 00	.10	.10
2	Lug, shakeproof solder #4	304 0317 00	.01	.02
2	Capacitor, ceramic disc, .01 ufd, +100—20%, 500 wv	913 3013 00	.42	.84
				$1.47

All or any portion of the above listed parts may be obtained by ordering from Collins Radio Company, Service Parts Department, Cedar Rapids, Iowa, at the indicated prices and will be available after November 1, 1957. All orders for these parts should specify the quantity, description, and Collins Part Number of the parts desired, and should make reference to this Service Bulletin.

Hints and Kinks For the Experimenter

AUDIO MUTING FOR THE COLLINS 75A-4

When the Collins 75A-4 receiver became available, many hams — particularly s.s.b. enthusiasts — were happy to find a provision for audio muting built into the receiver. The receiver has, in fact, provisions for two separate methods of receiver silencing. The first entails an "open the circuit while transmitting" means of biasing the r.f. amplifiers past cutoff. This method is quite satisfactory and requires no change in the average send-receive control circuit. However, the arrangement requires the application of positive 20 volts or more to the receiver's audio-muting circuit. Some hams have found existing sources of d.c. in their shacks for this purpose. The only charge necessary, then, was to change the contacts on the station's transmit-receive relay from "open" to "close" while transmitting. This is necessary because the 20 volts has to be applied to the receiver during transmitting periods. Others were forced either to build a suitable power supply or drag out a number of dry cells. Both of these alternatives, unfortunately, leave something to be desired.

In looking for another suitable arrangement, I found that the 75A-4 could provide the 20 volts d.c. needed for the audio-muting circuit and, also, retain the "open the circuit while transmitting" feature. At first, I simply opened the cathode-to-ground connection on the audio-output tube. However, to keep the pops caused by switching to a minimum, it was necessary to connect a filter capacitor across this circuit. This, in turn, brought up another problem. When the receiver's audio gain was turned up past the mid-point, modulation peaks blasted through with a monkey-talk quality (probably caused by leakage in the filter capacitor).

In any event, the voltage appearing across the capacitor while the silencing circuit was in the transmit position measured 21 volts. It was necessary only to run a jumper between this source and the regular audio-muting circuit and the problem was solved.

In case anyone should like to use this simple built-in power supply to silence their own 75A-4's audio, here is a step-by-step description of the modification.

1) For purposes of orientation, place the receiver, upside down, with the front panel toward you. Locate R_{98} and disconnect the wire that comes from the panel wiring harness and connects to the left (ungrounded) side of that resistor. Run a bare wire jumper between the terminal you just removed the wire from (the left terminal) and the ground terminal on the same strip (third terminal from the left). This disconnects the r.f. gain silencing circuit and leaves it in the "on" position.

2) Now locate the socket for the audio output tube, V_{22}, right below the terminal strip, and disconnect the bare wire running from Pins 2 and 3 to the ground lug on the terminal strip. Run a new wire between Pin 3 of the tube socket and ground. Then connect the free wire you originally disconnected from R_{98} to Pin 2 of the tube socket. Solder all these new connections.

3) Locate the "muting" terminal strip on the rear of the receiver. Connect a 10-μf. 150-volt capacitor between Terminals 2 and G, the positive end of the capacitor on Terminal 2. Now connect a jumper wire between Terminals 2 and M for the final step in the modification.

The receiver will now mute completely when no connection exists between Terminals 1 and 2 of the muting strip. Thus the normal "open while transmitting" breed of control circuit will perform nicely. Just connect this circuit to Terminals 1 and 2, and you are in business. (Note: If one side of your control circuit happens to be grounded, be sure to connect that side to Terminal 1).

One more thing. In the more recent 75A-4 receivers, a small subchassis has been added near the socket for V_{22}. This chassis mounts the potentiometers for S-meter zero and scale adjustment. In order to get at the terminal strip and audio output tube socket, it is necessary to remove the two chassis mounting screws and flop the chassis out of the way. Have no fears about moving the chassis, but be sure to remount it when the modification is completed.

Finally, operate the receiver with the combination power switch in the "standby" position. Otherwise, the silencing circuit will be bypassed and the receiver will remain on all the time. — *Lawrance H. Mitchell, W7BAS*

WIDE RANGE LOADING CAPACITANCE USING ONLY FOUR CAPACITORS

Although the circuit shown in Fig. 1 is not new, it has not recently been presented in connection with the popular pi-section tank circuit. Its versatility should make it useful in the output portion of a pi-section tank or in other applications where a wide range of capacitance is required. The novel feature of the arrangement is that only four fixed capacitors are required for a ten-step capacitance range covering 100 to 1000 $\mu\mu$f. in steps of 100 $\mu\mu$f. each.

S_{1A} and S_{1B} are mounted on a common index and therefore rotate together. Switch positions 1, 2, 3 and 4 connect the output terminals across capacitors C_1, C_2, C_3 and C_4, respectively, giving a

Hints and Kinks For the Experimenter

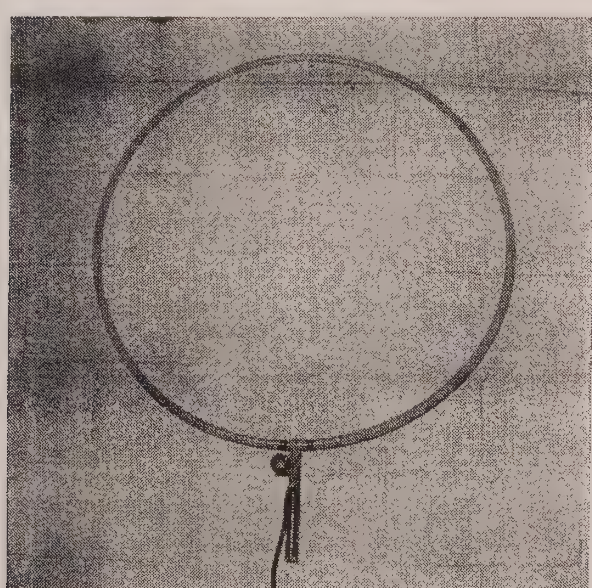
SOLDERING IRON CLEANER

Soldering iron tips can be cleaned easily without sandpaper, files or wire brushes simply by using a Sal-Ammoniac brick. The brick can usually be purchased from hardware or plumbing supply houses. Place the hot soldering iron tip against the Sal-Ammoniac brick and the oxide coating will be removed quickly.

— *Alex Toke, K2YVQ*

HULA D.F. LOOP

Shown in the photograph is my revised Hula Hoop. As the name signifies, it is a direction finding loop made from the infamous hula-hoop. Mine was designed for 75-meter operation so that I could participate in the local 75-meter transmitter hunts. Here are the constructional details: First a handle had to be attached. This was accomplished by drilling a hole in the hoop tube and attaching an 8-inch piece of broom handle with a wood screw. The loop consists of 185 turns of No. 18 enamel wire with the turns spaced about ⅜ of an inch apart. A check with a grid-dip meter indicated the resonant frequency of the hoop was a bit high. Rather than add more wire, I attached a 50 μμf. variable capacitor in series with the coil. Now I can tune the hoop from 3.5 to 4.0 Mc with the capacitor. The addition of a piece of low impedance coaxial cable connected to the capacitor and coil[1] completed the Hula D.F. Loop.



K5AHT's Hula D.F. Loop

— *Bobby J. Bellar, K5AHT*

[1] Campbell, "Hula-Hoop Helical Halo." *QST*, Feb., 1959

TRANSISTOR B.F.O.

Fig. 1 shows a transistor b.f.o. that can be used with any receiver having a 455-kc. i.f. It is basically a Colpitts oscillator and uses a 2N190 transistor. I built the unit in a b.f.o. can discarded from a 1.5 to 3 Mc. ARC/5 receiver. The oscillator tank $L_1C_1C_2$ is the b.f.o. coil assembly from the 1.5 to 3 Mc. ARC/5 receiver. The oscillator is coupled to the receiver detector through the 5-μμf. capacitor. Since the unit requires only 12 volts at 60 μa., it makes a convenient b.f.o. for mobile operation. It can also be incorporated into the home receiver by using the voltage divider shown in Fig. 2. The divider is connected to the receiver B-plus line.

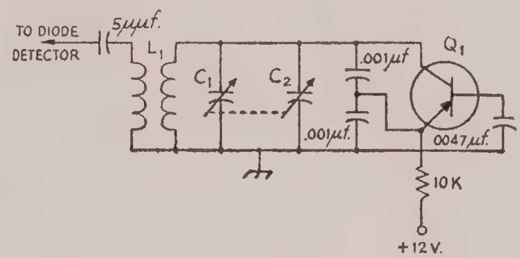


Fig. 1—Transistor b.f.o. The tuned circuit L_1, C_1, C_2 is the b.f.o. assembly from a 1.5 to 3 Mc. ARC/5 receiver. Q_1—2N190, CK768, 2N107

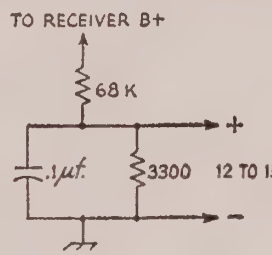


Fig. 2—The voltage divider connects to a 250 to 300-volt source. Resistors are ½ watt.

— *Charles Hartley, K6GQL*

A PANADAPTER CONNECTION FOR THE 75A-4

I found an easy way to connect a BC-1031C panadapter to my 75A-4 without the need for much more than lifting the cabinet lid. Connect the hot wire from the panadapter cable to the tube shield of the 6BA7 second mixer and ground the outer shield of the cable to the receiver chassis. When replacing the tube shield, push it down to within 1/32 of an inch from the tube base shield, but don't let it touch! This forms a concentric capacitor around the tube and provides sufficient coupling between the receiver and panadapter.

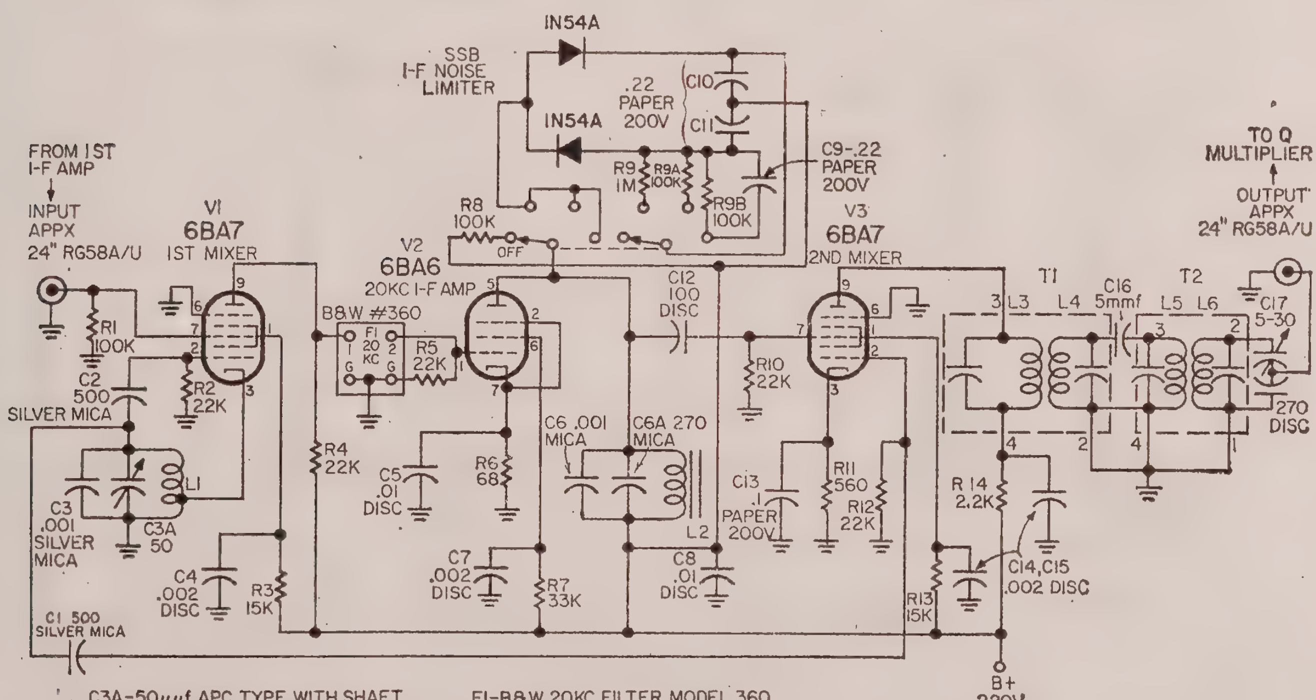
— *Robert W. Westcott, W8DNY*

20 Kc Filter Adapter and SSB I-F Noise Limiter for the 75A4

Wilfred M. Scherer, W2AEF

Here is a device which may be used to improve the skirt selectivity of the 75A4. It also furnishes continuously variable bandwidth down to .5 kc. A simple and effective SSB Impulse Noise Limiter is also included. The unit may be used for fixed 3 kc selectivity with other receivers that do not have selective filters, in which case it also provides the added feature of "band-pass tuning".

Some time ago the writer built a small adapter unit with a steep-skirted 20 *kc* filter to use with a communications receiver for SSB reception. An extremely effective SSB *if* noise limiter was also included. Quite a bit of interest was indicated by those who saw the unit in operation, and many felt a device of this nature could further enhance the performance of the 75A4 receivers (do we see lifted eyebrows?). We therefore proceeded to "gild the lily" with a unit modified for the purpose. The results were quite gratifying. These included steeper skirt-selectivity which permits positioning the *bfo* carrier in closer toward the filter passband thus producing more pleasant audio quality, better rejection of signals working on the opposite sideband, slightly narrower bandwidth with less adjacent channel crud, variable bandwidth from 3 *kc* to .5 *kc*,



C3A–50$\mu\mu$f APC TYPE WITH SHAFT
T1,T2–MILLER 455KC I-F #12C1
L1–OSC COIL (BROADCAST BAND) MILLER #A5496-C (MOUNT IN $1\frac{1}{8}$" SQ. CAN WITH C2 & C3)
F1–B&W 20KC FILTER MODEL 360
L2–80mh MEISSNER #19–6866

Fig. 1—Circuit of the 20 kc filter and SSB noise limiter. Condenser under C17, that is unmarked, is C18.

and excellent noise limiting on SSB or CW which is also applied to the *avc* system to minimize loss of receiver gain during trains of noise pulses.

The circuit of the 20 *kc* adapter, as used in the 75A4, is shown in fig. 1. The circuit of the 75A4 is opened between the first *if* stage and the Q-Multiplier, with the first *if* output being fed to the first 6BA7 mixer in the 20 *kc* adapter. Since the signals at this point are received after they have passed through the mechanical filter in the receiver, the 3 *kc* input bandpass frequency range is approximately 453.5 to 456.5 *kc* (at the 6 *db* points). With the mixer oscillator tuned to 473.7 *kc*, the difference between these frequencies will appear at the output of the mixer, and will result in a bandpass range from 17.2 to 20.2 *kc* (473.7-456.5 and 473.7-453.5) which is the 3 *kc* bandpass spread of the B & W model 360 filter.

The low frequency signals are then passed through the 20 *kc* filter where any signals outside of the passband of the filter (which may result from the mixing of signals at the sides of th 455 *kc* mechanical filter passband) are further attenuated. The output of the 20 *kc* filter is then amplified by the 6BA6 stage, and is next fed to the second 6BA7 mixer where it is again combined with the 473.7 *kc* oscillator (from the first mixer) to produce output signals from the adapter which are in the same passband range applied to the first mixer (453.5 to 456.5 *kc*). The output from the adapter is finally fed back to the Q-Multiplier of the 75A4.

Thus we have taken the signals through both the 455 *kc* mechanical filter of the receiver and the 20 *kc* filter of the adapter. By combining the characteristics of the 455 *kc* filter, fig. 2A, with those of the 20 *kc* filter, fig. 2B, the composite result will be that indicated by the curve of fig. 2C, where it will be seen that the overall slope of the skirts has been steepened thus making better filter performance possible.

As may be seen from the curves, the 3 *kc* bandpass range (453.5 to 456.5 *kc*) of the mechanical filter is that using the 6 *db* points as the reference. The B&W model 360 20 *kc* filter range, using the same reference points, is slightly less than that of the mechanical filter, being about 2.8 *kc*. This results in a slightly narrower overall bandpass in addition to the steepening of the skirts. The combination also offers some improvement (over a single filter) when a 2.1 *kc* mechanical filter is involved in place of the 3.1 *kc* one.

The 473.7 *kc* oscillator originally was crystal controlled; however, it was found that the exact mid-frequency of the various mechanical filters differed somewhat, which resulted in an unsymmetrical passband in some instances. This possibility is eliminated by the use of the variable self-excited oscillator which permits the selection of the exact frequency required in each case to exactly center, or superimpose, the passbands of the filters in the receiver and the adapter. Oscillator stability is no problem at this frequency, and, in fact, extreme oscillator stability is not required, as far as the received signal is concerned, for the reason pointed out at the end of the following paragraph.

Variable Bandwidth

The use of a variable oscillator, in the adapter, leads us to another possibility. If we change the oscillator frequency from 473.7 *kc*

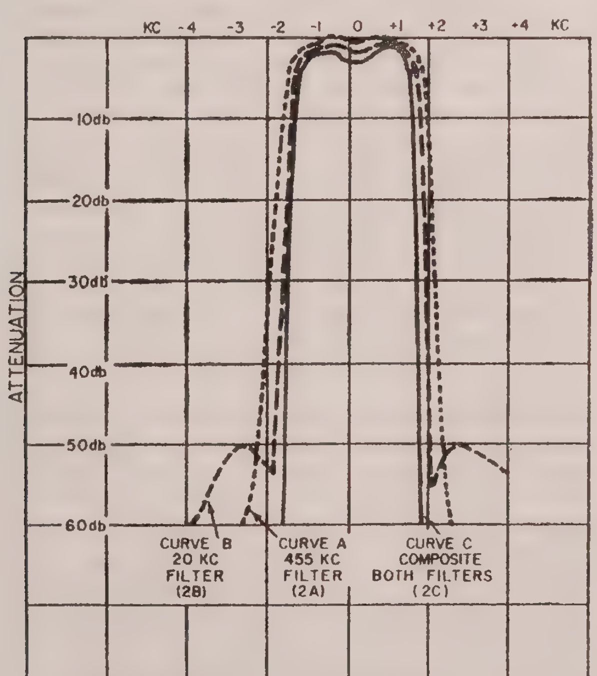


Fig. 2—Combined curves of the 20 and 455 kc filters produce the resultant shown in C.

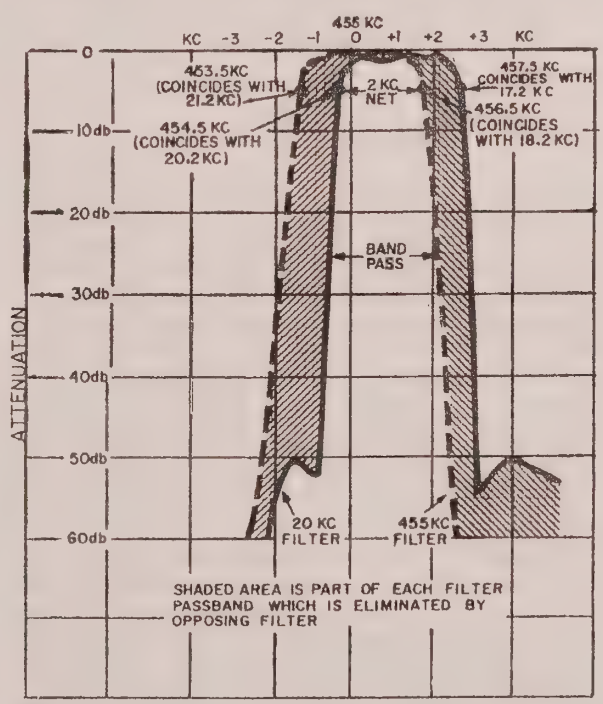
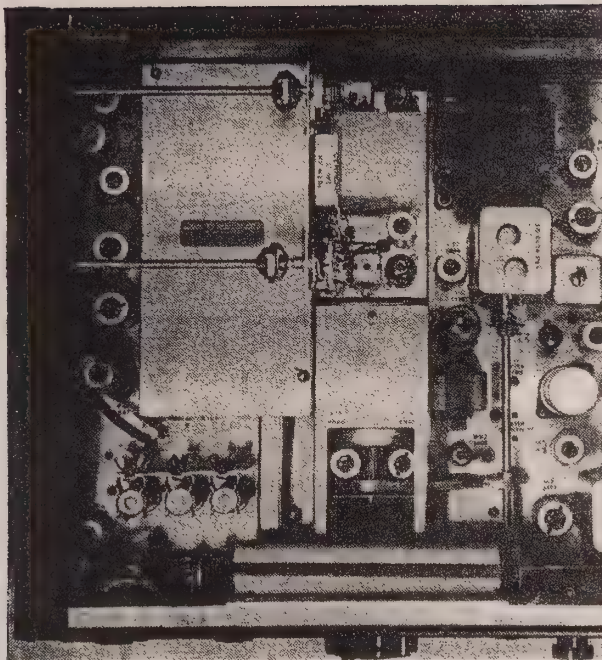


Fig. 3—Variable bandwidth characteristics for 2 kc bandpass—454.5 to 456.5 kc.



The 20 kc adapter is built on a chassis which is mounted at the rear center shelf behind the vfo in the 75A4. The square can near the center of the chassis is the B&W 20 kc filter. At the rear is the 1st mixer tube, next to which is the can which contains the slug-tuned oscillator coil L1. A lead is brought out of the top of this can for a connection to the oscillator trimmer C3A which is mounted immediately above the oscillator can, and on a panel which is fastened to the left side of the chassis. In front of the 20 kc filter are the 20 kc if amplifier and 2nd mixer tubes, together with the 455 kc if transformers T1 and T2. T2 cannot be seen, since it is under the noise limiter switch which is mounted above it on the side panel. The capacitor at the left top of the 20 kc filter is C9. C10 and C11 are mounted vertically along the panel between the if transformers and the 20 kc filter. The crystal diodes are also mounted here. L2 is mounted under the chassis, as is C17 which is placed so that it may be adjusted from the bottom. All the adapter leads come out of the rear of its chassis, and they run through the slot at the rear of the receiver's chassis. The control shafts for the oscillator trimmer and the noise limiter switch pass through the ventilation slots on the side of the 75A4 cabinet where they are held in place by panel bearings which neatly fit the slots.

to 474.7 *kc*, the bandpass output of the *first mixer*, (before the 20 *kc* filter) in the adapter, will be 18.2 to 21.2 *kc* (474.7-456.5 and 474.7-453.5). Then if we superimpose the curves of the two filters accordingly, (see fig. 3), we will find that they overlap at opposite ends, with the 20 *kc* filter taking over the resulting skirt selectivity at 454.5 *kc*, and the 455 *kc* filter taking over at the 456.5 *kc* skirt. The composite result is a bandpass output from the adapter of 454.5 *kc* to 456.5 *kc*, or a net spread of 2 *kc*. Since the process involves mixing and remixing with the same oscillator, no retuning of the receiver is required to keep the signal on frequency.

From this it can be seen that we now have a system whereby the bandpass spread can be continuously varied from 3 *kc* down to about .5 *kc* simply by changing the frequency of the adapter's oscillator. When the bandwidth is narrowed however, the steepness of the skirts is not as good as when the effects of both filters are equally superimposed on one another to produce the widest bandwidth. It will approach that of one of the filters alone as the bandpass is narrowed below 2.6 *kc*. In the case cited above, at 454.5 *kc* output, the skirt will follow the curve shown at the 20.2 *kc* side of the 20 *kc* filter, but at 456.5 *kc* output, it will follow the curve of the 455 *kc* filter shown at its 456.5 *kc* side. Nevertheless, the variable bandwidth feature can be helpful under adverse conditions of QRM, especially in cases where the 75A4 is not already equipped with 2.1 *kc* or .8 kc mechanical filters.

In the first model of the adapter, which did not include the 20 *kc* amplifier, some difficulty was experienced with the 473.7 *kc* oscillator signal's leaking through the second mixer, and passing through the 75A4's 455 *kc if* strip (even though a degree of selective isolation was provided by the loosely coupled *if* output transformers in the adapter). This affected the *avc* system, and biased the AM circuits to a point where a considerable loss in audio level resulted during AM reception. Inclusion of the amplifier raises the overall resulting 455 *kc* output level of the adapter sufficiently to permit the reduction of the oscillator signal (which leaks through the second mixer) by means of overall attenuation which is accomplished with C17 and C18. The amplifier is also needed to furnish ample operating level for the SSB *if* noise limiter.

SSB IF Noise Limiter

The SSB noise limiter employs two crystal diodes connected in a full wave arrangement in shunt with the output circuit of the 20 *kc if* amplifier (see fig. 1.), and as such is an *if* type of noise limiter (IFNL). The diodes are self biased by the rectified potential developed across R9. The time constant, resulting from the combination of R9, C9, C10 and C11, is such that the bias varies nearly at a syllabic rate with an SSB signal. This tends to prevent any limiting action, and thus allows the signal to pass on virtually unhindered, but when a short noise pulse is received, the bias cannot rise rapidly enough to prevent limiting, and the amplitude of the pulse is then reduced by the action of the diodes.

The usual type of noise limiter which follows the detector not only clips the noise peaks, but also tends to clip off the tops of the audio peaks as well. This squares off the audio wave, and

causes severe distortion when the clipping level is set for satisfactory noise limiting action. Considerably less distortion is experienced when the SSB *ifnl* is used, since the most severe limiting takes place only on short steep fronted pulses. Besides this, its action tends to compress the limited signal instead of squaring it off by clipping. Because of the self-bias, which is developed when an SSB signal is received, little limiting of the signal is found, except at the first impulse of a syllable, usually the one at the start of a word.

Because the *ifnl* is installed ahead of the detector and the *avc* rectifier, the effect of limiting at the start of a word softens both the audio and *avc* attack at that period. This permits the use of maximum *rf* gain with full *avc* action without the hard popping attack on strong signals which is usually experienced with the 75A4.

Another advantage of a noise limiter installed ahead of the *avc* rectifier is that it helps to prevent a succession of noise pulses from activating the *avc* system which would result in an attendant loss of receiver gain during such periods.

High back-resistance crystal diodes, type 1N54A, are used in the *ifnl.* Vacuum tube diodes are not satisfactory in this particular application of the *ifnl.* SW1 is the noise limiter on-off switch. It also selects different degrees of limiting by changing the time constants and the self biasing resistors. When the switch is at off, *R8* is placed across the amplifier circuit to hold the gain down to near that realized when the noise limiter is in use.

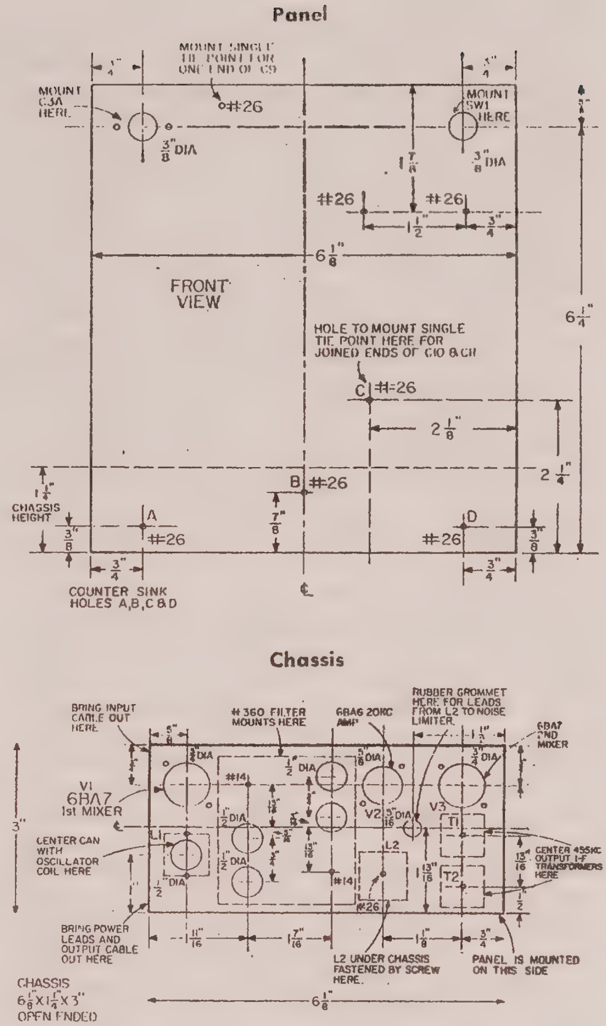


Fig. 4—Dimensions and component location for the chassis and panel.

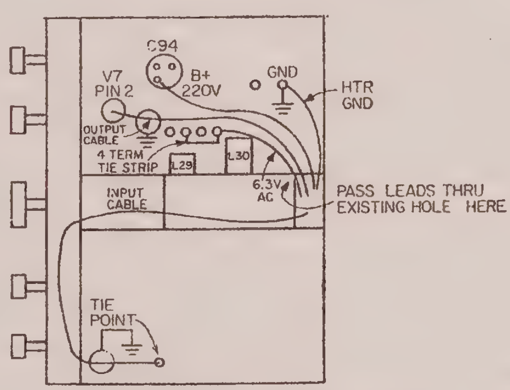


Fig. 5—Adapter connection points.

Construction

The adapter unit is built on a 6⅛" x 1¼" x 3" open-ended chassis (Bud #1628) which allows it to be mounted in the 75A4 directly behind the *vfo*. A panel is fastened on one side of the chassis to permit mounting of the noise limiter switch and the trimmer for the variable oscillator, so that they may be controlled by shafts passing through the ventilation slots on the side of the 75A4 cabinet, thus eliminating "butchering" of the front panel. The only holes required in the 75A4 are four small ones for screws used to secure the adapter to the shelf on which it is mounted. The location of the components and guide dimensions may be found in fig. 3.

Power is derived directly from the 75A4, and although the B plus drain is approximately 30 *ma*, no adverse effects on the power components of the receiver have been found. However, if the constructor is apprehensive in this regard, a small power supply, for the adapter, can be installed underneath the shelf on which it is mounted.

Because of the mechanical and physical complications which might become involved, no provision has been included in the adapter to switch it in and out of the circuit, so any use of the 6 *kc* mechanical filter would still restrict the overall bandwidth to that of the adapter. If a switch is added, the input and output circuits should be well isolated from one another at the switch to prevent leakage around the unit. In this case it would also be more expedient to build the adapter as an outboard unit with its connecting leads passed through the ventilation slots at the rear of the 75A4 cabinet.

Installation and Adjustment

Before the adapter is installed in the 75A4, several adjustments must be made.

Remove the bottom plate from the 75A4. Connect the coax and power leads from the adapter and place it in the receiver as shown in the photograph. Run all the leads through the slot at the rear of the shelf on which the adapter is placed. If not already done so, mounting holes may be marked and drilled in the shelf at this time. Then use self-tapping screws to fasten the unit to the shelf. Trim all the leads for the correct length to reach their respective connecting-points, (see fig. 5), but do *not* connect them. The leads should run under the chassis as shown.

Remove the adapter from the 75A4. Disconnect any antenna from the receiver, and then stand the latter on its left side. Now, check the *bfo* alignment as described in the instruction manual for the 75A4 (item 7 under Maintenance). Then, as a matter of interest, check the normal maximum possible sideband suppression and bandwidth (Passband Tuning at 1.5 *kc*) as described later in this text in steps 1 and 2 under Operation.

Next, set the *avc* at *Fast*, Selectivity for the *3.1 kc* filter, *Bandswitch* at the second *10-Meter* position, *AF Limiter* at *Off*, *Detector* for *SSB*, *Passband Tuning* at Zero. *Rejection Tuning* at *Off*, *RF Gain* at *maximum*, *AF Gain* at about *9 o'clock*, and the *Power Switch* at *Calibrate*.

Tune in the crystal calibrator at 28.6 *mc* until a zero beat-note is obtained. Then adjust the *Antenna Trimmer* for a *minimum S-Meter* reading, which will be around S-5. Turn off all *ac* power, but leave all the other controls set as just described above.

Referring to fig. 5, on the 75A4 disconnect the inner conductor of the coax lead from pin 2 of V7. Disconnect the other end of this coax inner conductor from the tie-point near the front wafer of the *selectivity* switch.

With the adapter unit placed outside of the 75A4 cabinet, *temporarily* connect its coax and power leads to their respective points as follows:

Connect the inner conductor of the output coax lead to pin 2 of V7. Connect its outer shield to the nearest ground lug.

Connect the inner conductor of the input coax lead to the tie-point from which the internal 75A4 coax lead was just disconnected as described above. Connect its outer shield to the nearest ground terminal.

Note that the internal 75A4 coax lead is left disconnected at both ends. Stray leakage is minimized by making the connections as just described, rather than by making them through only one break directly at the tube socket.

Connect the power leads as indicated in fig. 5.

Now, on the adapter set the *noise limiter* switch at off, the *variable oscillator* trimmer at the center of its range, and turn the tuning slug of the oscillator coil all the way in (clockwise).

Apply power with the 75A4 *power* switch set at *on*. Slowly rotate the adapter's oscillator tuning slug counter-clockwise until a low pitched background noise is heard. The oscillator will now be tuned to approximately 436.3 *kc*. Rotate the slug control further counter-clockwise until a loud beat-note is heard. Adjust for zero beat. The oscillator frequency will now be about 455 *kc*, and the S-Meter will read almost full scale. Again rotate the oscillator slug counter-clockwise until a low pitched background noise is heard. The oscillator frequency will now be about 473.7 *kc*. Turn on the crystal calibrator, and adjust the oscillator slug for a maximum S-Meter reading. Be sure the adjustment of any of the other controls has not been disturbed during the above steps.

Peak up the S-Meter reading by means of the slugs in the *if* output transformers of the adapter. (L4, L5, L6 and L7). Alternately adjust C17 and the slug of L6 (this should be the one controlled from the top of the *if* can) until the S-Meter reading is the same as, or just slightly lower than, that obtained at the time when the antenna trimmer was adjusted for the minimum S-Meter reading before the adaptor was connected into the circuit.

The overall gain has now been adjusted for the normal receiver gain. The preceding steps may also be performed when the adapter is permanently installed if suitable holes are made in the shelf of the 75A4 to enable one to adjust *C17* and the slugs at the bottom of the *if* cans in the adapter.

Next remove all *ac* power from the 75A4, and disconnect the adapter's coax and power leads from the receiver. Mount the adapter unit in the 75A4, and this time *permanently* connect its leads back on the receiver. Put the bottom plate back on the 75A4, and stand the latter in its normal position. Connect the control shafts to the adapter with suitable knobs placed on them at the side of the receiver cabinet.

Place the adapter's noise limiter switch at *off*, and its *variable oscillator trimmer* control at the center of its range. Apply power to the receiver with the *power* switch at *On*. Adjust the adapter's oscillator frequency to near 473.7 *kc* by tuning its slug for a low pitched background noise as described above. This should be at or near the point found when the unit was initially tuned outside of the cabinet.

Turn on the *crystal calibrator*, and tune the signal to zero-beat. Peak up the S-Meter reading, first by means of the adapter's *oscillator slug*, and then by adjustment of the *antenna trimmer*.

With the signal at zero-beat (be sure the *passband tuning* is still set at zero), adjust the *zero set* so that the hairline coincides exactly with the zero on the 75A4 dial. Check the

S-Meter reading when the dial is set 1.5 *kc* each side of zero. The S-Meter reading should be identical at these two points. If it is not, slowly readjust the adapter's *oscillator slug* to the point which results in identical meter readings with the dial 1.5 *kc* each side of zero. Note that this step is similar to the one given in the 75A4 instruction manual for its *bfo* alignment.

With the *calibrator* off (*power switch* at *On*) the pitch of the background noise should be approximately the same at equal settings of the *passband tuning* each side of its zero. If at any time the oscillator frequency is shifted by drift or adjustment of the oscillator trimmer for variable bandwidth operation, this aural check may serve as a rapid means of finding the correct setting of the oscillator control for normal bandwidth use. This method may also be used, instead of that described in the preceding paragraph, for the initial alignment.

Operation

On the 75A4, the setting of the passband tuning determines the attenuation at frequencies adjacent to the passband of the mechanical filter. Attenuation of signals on an unwanted sideband increases as the passband tuning is set further away from zero, while at the same time the effective bandwidth at the upper limit of the passband (in the vicinity of 3 *kc*) increases. When the 3.1 *kc* filter is used for SSB reception, most operators set the passband tuning at 1.5 *kc*. Under ordinary conditions this may be quite satisfactory, but if good rejection of a signal on the opposite sideband is needed, the passband tuning must be moved out further but as already pointed out, the effective bandwidth will increase at the same time. For example, if the passband tuning were moved out an additional 500 cycles to 2 *kc*, the upper cutoff will occur at approximately 3500 cycles instead of 3000 cycles.

These same principles follow when the 20 *kc* adapter is used; however, due to the increased steepness at the skirts of the overall bandpass characteristics, the bandpass tuning may be brought closer to zero for a given amount of opposite sideband rejection, while at the same time the effective overall bandwidth may be kept within the desired limit. When the 3.1 *kc* filter is used in conjunction with the 20 *kc* adapter, passband tuning settings of from 1.25 to 1.5 *kc* will result in excellent sideband suppression with pleasing audio quality and less adjacent channel crud. If the 2.1 *kc* filter is used with the adaptor, the passband tuning may be set at 1.25 to 1 kc with similarly improved results over the use of the mechanical filter alone.

The degree of attenuation for any frequency deviation from zero-beat, at any setting of the passband tuning, may be checked by ear, or by noting the S-Meter readings as the dial is tuned from one sideband to the other while the crystal calibrator is used for the test signal. Examples of how this may be done are as follows:

1. Turn the *rf gain* to maximum with the *avc* at *Fast*. Set the *Passband Tuning* at zero, turn on the *crystal calibrator*, and tune the receiver to zero-beat. Align the *Zero Set* with the zero on the dial. Then set the *Passband Tuning* at 1.5 *kc* on the *Upper* side. Rotate the *Main Dial* towards the *low* frequency side of zero, tuning for a maximum S-Meter reading which will occur over nearly a 2 *kc* spread, from about .5 *kc* to 2.5 *kc* on the *low* frequency side of zero-beat. Now rotate the dial back towards zero, noting the S-Meter readings as the dial is tuned to various degrees of frequency away from zero. Go past zero-beat on to the other side, at which time the S-Meter readings should drop sharply, indicating the possible amount of suppression on the other sideband for a given deviation from zero. Repeat the above steps with the *Passband Tuning* set at 1.5 *kc* on the *Lower* side, where the maximum readings will now occur when the tuning dial is on the *high* frequency side of zero-beat. These general procedures also may be followed with the Passband Tuning placed at settings other than 1.5 *kc*. The suppression should be the same for either sideband when the Passband Tuning is set at the same point on the related side in each instance. If it is not so, slightly readjust the oscillator trimmer to produce this result.

2. The same procedure may be carried out by ear instead of using the meter as an indicator. To do this, follow the above steps, except turn the *AF Gain* nearly all the way on, and back down on the *RF Gain* to a point where a beat-note of about 1000 cycles can be comfortably heard on the wanted sideband. If the Passband Tuning is set for *Upper*, the beat-note will be heard when the main dial is tuned to the *low* frequency side of zero-beat, or on the *high* frequency side when the Passband Tuning is at *Lower*. Then rotate the dial toward the other side of zero-beat, and audibly note the drop in level of the resulting beat-note. It should be barely perceptible, if heard at all, at any beat-note of from 100 cycles up.

Either one of the two above methods may also be used for checking the effective overall bandwidth by observing the attenuation near the 3 *kc* sides of the passband. Operation and adjustment when the 2.1 *kc* mechanical filter is in the circuit may also be carried out in a similar manner, in which case the Passband Tuning may be set closer to its zero for a given degree of unwanted sideband suppression.

Best sideband rejection and less adjacent channel crud will be experienced when a minimum amount of *avc* is used. (The Rejection Tuning of the 75A4 is also more effective under this condition.) The degradation of selectivity when maximum *rf* gain and *avc* are used may be demonstrated by comparing the skirt atten-

[*Continued on page 124*]

TRANSISTOR TEST [*from page 115*]

these characteristics can be obtained from the manufacturer's data on the transistors that they produce. However, several general statements may be made concerning testing transistors with this tester. First, considering saturation or collector cut-off current, any low or medium power transistor (2N34, 2N35, 2N107, CK722) may be expected to read below 20 μamp if in good condition. If the reading is above 50 μamp, the transistor may be assumed to be bad. This test is similar to testing a vacuum tube on a tube tester. If the tube shows shorted, it may still work in many non-critical circuits. However, in both cases a good tube or transistor will work better.

In the relatively high power type of transistors, for instance 2N68, 2N95, 2N155, etc., the saturation should not exceed 500 μamp.

Second, concerning current gain, if the transistor shows at least two-thirds the manufacturers rating it may be considered to be satisfactory. The current gain Beta is equal to the current gain ALPHA by the following equation:

$$\text{Beta} = \frac{\text{Alpha}}{1 - \text{Alpha}}$$

In general, if the saturation current reads below 30 μamp on low and medium power transistors and below 200 uamp on high power types, the transistor can be considered to be in good shape.

The cost of building this tester will be repaid the first time you use it to service any transistorized equipment. It is as definite as a tube tester, and will simplify servicing of transistors and their circuits. ■

20 KC FILTER [*from page 37*]

uation by ear, as described above, with the same procedure conducted by ear while the *rf* gain is wide open with full *avc* action.

When the variable bandwidth arrangement of the adapter is to be used for SSB reception, its oscillator must be tuned *higher* in frequency (decrease *C3A*) when the Passband Tuning is set for *Lower*, and *lower* in frequency (increase C3A) when the Passband Tuning is set for *Upper*. This will permit leaving the Passband Tuning set at one point as the bandwidth is narrowed, but as it is decreased below 1.5 *kc*, the Passband Tuning may have to be brought a little closer to zero. If sidebands are switched by changing the Passband Tuning from one side to the other, the adapter's oscillator will likewise have to be retuned as indicated above; however, under normal operation with the bandwidth fixed at maximum (centered with the 3.1 *kc* filter as described in the preceding paragraphs) no retuning of the adapter's oscillator will be required when sidebands are switched.

It is recommended that the adapter normally

be used for fixed bandwidth operation (maximum) during SSB reception, because a further narrowing of the bandwidth usually is not required, except in special cases of extreme interference; however, varying and narrowing the bandwidth for CW reception may be more desirable. In this case it is suggested that the adapter's oscillator trimmer be set near the maximum or minimum end of its range where it causes the overall bandwidth to narrow down to about .5 *kc*, although a loss of *rf* level (about 12 *db*) will be experienced at the same time. The Passband Tuning may be rotated to whichever side of zero produces the desired effect of peaking or rejection in a manner similar to that followed when a peaking Q-Multiplier is used.

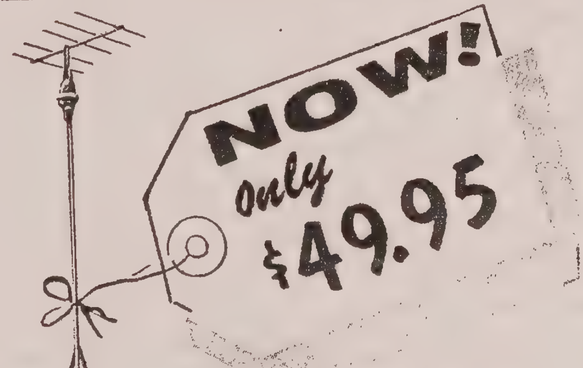
When the noise limiter is in service, slight non-linearity can cause a small amount of distortion depending on the degree of limiting action which is used. Part of this is also due to a "hang-over" effect at the end of a word which is caused by the time constant of the circuit. These effects are minimized when the least amount of limiting is used. It will generally be found best to use only as much limiting as is needed to realize the best intelligibility of the signal during prevailing noise pulses. It will also usually be best to set the *avc* at *slow* and use a moderate amount of *avc* (back down on the *rf* gain).

As mentioned previously, the use of the *ifnl* also softens the attack at the start of a word, and thus smoother *avc* action and more pleasant listening is realized. The *ifnl* will also be found useful for noise suppression during CW reception. In addition, it will considerably reduce key clicks.

The *if* noise limiter is considerably more effective for SSB and CW reception than the existing noise limiter in the 75A4, and less distortion, for a given degree of limiting, is experienced together with little loss of level; however, the *ifnl*, as arranged in the adapter, is not as effective with AM reception as is the 75A4 noise limiter.

Conclusion

The 20 *kc* adapter, herein described, has been set up specifically for use with the 75A4. Similar type adapters, using the same general basic principles of the system, may be worked out for use with other receivers. If such a receiver does not already include any selective arrangement for SSB operation, a 20 *kc* adapter will provide the necessary selectivity to make an old receiver well suited for SSB. In addition, instead of providing variable bandwidth, varying the adapter's oscillator tuning control will furnish "passband tuning", thus making it possible to position the carrier at either side of the filter for lower or upper sideband reception. This eliminates the need to retune the receiver or the *bfo* when sidebands are changed. ■



75A4 Modification

Every once and a while a modification comes along that really makes a major improvement in a piece of station equipment. Our commendation this month goes to Stan, W6QFE, and George, W6PKK, who have come up with a change in the circuitry of the 75A4 that deserves consideration. Changing the second mixer, a 6BA7 to a 6U8A, increases the signal to noise ratio appreciably, sharpens an already sharp receiver and ends the annoying pumping of the *avc* when the *rf* gain is run wide open. We have made the modification at our shack and, along with others who have done the same, found it to be an improvement in an already fine receiver.

The job can be done in about two hours by following the step by step directions below. The original tube socket may be left in place or a new one inserted with the socket turned 180 degrees so that the rewiring job is made easier. Several of the component leads will have to be lengthened or new ones added. If you replace the socket, make a note of where each wire was attached to the original socket for proper replacement.

1. Remove V5, 6BA7
2. Remove bottom plate and ANT. TRIM. rod.
3. Disconnect all connections from tube socket V5 except;
   a. pin 4.
   b. pin 5, also remove ground.
   c. pin 6 remove ground.
4. Remove R25 and C60, not used.
5. Remove R23, not used.
6. Remove R24, not used.
7. Carefully remove C58 from pin 2, leaving the other end connected.
8. Change C59 from pin 6 to ground. The other end remains on pin 3.
9. Connect R114 to pin 2, reconnect pin 5 to ground.
10. Add new 110K ½W resistor to tie point where R25 was connected and connect other end to pin 3.
11. Add new 47K ½W resistor from pin 3 to ground.
12. Connect the wire which was removed from pin 9 to pin 6.
13. Connect wire from PTO which was removed from pin 2 to pin 7.
14. Add new 1K 1W resistor from pin 7 to ground.

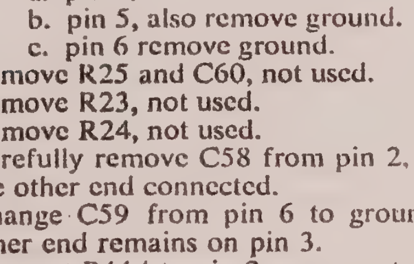


Fig. 1—Modified area of the 75A4. Text explains the procedure and results.

15. Add a new 180 mmf condenser from pin 7 to ground.

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16. Connect C58 to pin 7.
17. Replace ANT. TRIM. rod, bottom plate and insert 6U8A as V5.
18. Calibration will be off 1 or 2 *kc;* correct as per instruction book.

No loss of gain was experienced by making the change; in fact, we have had reports of anywhere from 6 to 10 *db* additional gain after the change was made. Now we are able to tune out a 50 *db* over S9 signal in less than 4 *kc*, dropping it below S9 at about 3.5 *kc* from the transmitted frequency. A 6678, ruggedized 6U8A, may be used as V5.

New parts needed: 1—47K ½W resistor
1—100K ½W resistor
1—1K 1W resistor
1—180mmf capacitor
1—6U8A

SSB Around The World

Bob, TG9AD is now on vacation in Europe with the family, meeting some of his overseas SSB friends . . . Sue, ZS5OP, is a most welcome addition to the ranks of XYLs on SSB. Licensed for 14 years, Sue has been on SSB for the past year and a half with her OM, Bert, ZS5OM . . . Goran, SM6SA, has been faced with a terrible choice these past few months: he doesn't know whether to take advantake of the Spring weather by spending more time on the golf course or stay indoors and enjoy the excellent reports he's been getting with his new 100V-600L combination. The only suggestion we can make is that he put his new rig in a golf cart and operate mobile between strokes! . . . Jan, OK1JX, informed us recently that there are now six SSB stations in Czechoslovakia . . . During his first two months on SSB, Ib, OZ5KQ, worked over 100 countries with his OZ3EA exciter and an 813 final. Ib is percussionist with the Danish Symphony Orchestra and recently played host to Rauol K2AOS, who visited Copenhagen to make plans for recording the Orchestra. Ib, by the way, is very much interested in contacting the SSB gals with a view toward achieving his YLCC certificate . . . Ben, F7AH, ex-W4IED, an Air Force Colonel stationed at Fountainbleu recently joined the SSB group with help from Norry, F7GZ while Rene, OE1RZ, became so enthusiastic the first day he put his HT37 on the air that one could hardly keep up with his rapid comments . . . Joss, ZS6L, is running an SB10-Apache combination and keeping weekly skeds with K4CKZ . . . Looks like Bob, VK3SK and XYL, Alys, are getting closer and closer to the States; they visited Moshe, 4X4FA, in early April and contacted their good friends, Art W2CYK, and Madeleine, W2EEO, from Israel . . . George, G3AWZ, puts out a tremendous signal from England with just 140 watts PEP and a 3 Element beam. Day or night, no matter what the conditions are, George can always be heard ragchewing with his many friends . . . John, ZE4JN, will be one of the main speakers at the West Gulf Convention in Dallas on June 18-19. John will be a houseguest of Doc, W5RHW, in Houston and then plans to travel up the East Coast meeting SSB friends.

Certificates And Stickers

To clarify the requirements for the SSB DX Certificates and stickers—the cards submitted should clearly state "2-Way Single Sideband." There has been some discussion about Double Sideband cards being eligible for these awards and it has been given careful consideration. We feel that, since Single Sideband is being used by almost all sideband stations and since the two systems are radically different technically, there are sufficient grounds for separate classification of the method. One of the major benefits of SSB is the frequency conserving signal it puts on the air and we feel that Double Sideband, with its wide bandwidth and receiving phasing problems, should not be encouraged for amateur use. In fairness to operators who have worked

[Continued on page 104]

I.F. Noise Limiter

BY WALTER J. STILES,* K5ENB/W7NYO

Receiver noise-limiter development appears to have moved contrary to the flow of the art since the original work of Lamb.[1] While the pattern for over-all receiver circuit development has followed the path of continually increasing complexity, noise-limiter development has, essentially, taken the direction of simplification. This has necessitated compromises which have been justified by the fact that even the best and most complicated receiver noise limiters could be considered only relatively satisfactory.

Ideally, a noise limiter should operate at the antenna input in order to prevent overloading of any of the receiver circuitry. Such a location for the noise-limiting circuit is currently impractical, primarily because insufficient impulse intensities are available at this point. The Lamb circuit functioned in the i.f. section, but subsequent general practice has moved the limiter farther along the receiver chain to the audio output of the second detector. This change, while providing simplification, has exposed more of the receiver circuitry to bombardment by noise pulses, and thus a general deterioration in performance.

The circuit described here moves the noise-limiting action a step back toward the antenna. The additional protection thus provided is especially desirable for the product detector, which is rapidly becoming commonplace in most communication receivers. The noise-limiting action is in all ways comparable, and in most cases superior, to that of the more conventional audio limiters. The limiter functions equally well on a.m., c.w. and s.s.b. signals,[2] with product and diode detectors, and introduces neither loss of receiver sensitivity nor unacceptable audio distortion. The operating threshold is adjustable. In practice there is an apparent improvement in signal-to-noise ratio, an effect particularly noticeable in reception of weak c.w. in a crowded band dominated by higher-intensity signals.

In the circuit shown in Fig. 1 the 6AL5 serves as a symmetrical pulse-type shunt i.f. noise clipper with adjustable threshold and automatic signal reference. When resistor R_1 is switched into the circuit by closing S_1, capacitors C_1 and C_2 charge to the average peak level with such polarity that they oppose the flow of current in the limiter tube. When a sudden change in level occurs (this normally represents noise pulses) the excess signal is shunted across the i.f. output transformer. Thus a large percentage of the noise pulses are prevented from reaching the detector circuit.

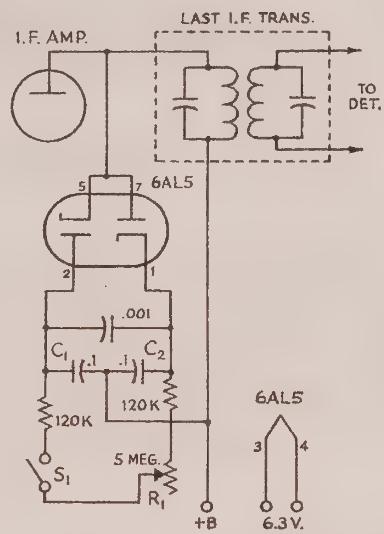

Fig. 1—Circuit of the i.f. noise limiter. Capacitances are in μf. C_1 and C_2 are paper tubular. R_1 is a 5-megohm control, linear taper.

The circuit can be added to most receivers without affecting their original performance except when S_1 is closed. The exact frequency of the i.f. amplifier is relatively immaterial, and the circuit has been tested on both 455 and 2215 kc. with comparable results. Its use to provide noise-limiting action in an automobile receiver should prove to be most effective, and the installation could be made without compromising the receiver's use for broadcast reception. The mechanics of the installation should be such that the leads to the i.f. transformer are as short as possible. If the threshold control R_1 is necessarily mounted in a remote position, it should be connected through a length of flexible coax, such as RG-58/U. Preferably, it should be mounted as close to the 6AL5 tube as practical. If the builder is tempted to return the center tap of C_1 and C_2 to ground rather than to the B+ end of the i.f. transformer, he will discover a noticeable deterioration in performance.

The amount of use of any receiver feature is usually directly proportional to its practical effectiveness. In three years of operating a 75A-4 at K5ENB, the receiver's original noise limiter was switched on less than a total of ten minutes. Since installing the circuit under study, it has never been switched to the "off" position.

* 2801 Dorothy, N.E., Albuquerque, N. M.

[1] Lamb, "A Noise-Silencing I.F. Circuit for Superhet Receivers", *QST*, February, 1936.

[2] This is the case with the author's 75A-4 receiver, in which, because of the particular circuit arrangement used, it is unlikely that any substantial amount of b.f.o. voltage is present in the primary of the last i.f. transformer. In other receivers this might not be so. In such case the b.f.o. voltage in the i.f. transformer primary would determine the limiting level on c.w. and s.s.b. signals, or at least put a "floor" under the limiting level. — *Editor.*

"IFNL"
An SSB IF Noise Limiter

Wilfred M. Scherer, W2AEF

A really effective SSB noise Limiter is a rarity. The IFNL is a simple and inexpensive device which does an exceptionally fine job of impulse-noise suppression and provides good SSB signal inteligibility under adverse noise conditions. The unit shown here was constructed for installation in the 75A4, but it may be used with other receivers as well.

Ignition impulse-noise interference certainly can ruin the reception of a signal, especially if it is a weak one. Many types of noise limiters have been devised to cope with this situation, and most of them, particularly the popular TNS, do an excellent job in connection with AM reception, but when the reception of SSB or CW signals is involved, the conventional noise limiters are relatively unsatisfactory. Some receivers are equipped with so-called CW or SSB noise limiters, but from what has been seen so far, none of these is very satisfactory, with the possible exception of the *Collins* Noise Blanker, which carries a terrific price tag ($120)!

A very simple and extremely effective SSB IF noise limiter (IFNL) has been used by the writer for several years in a mobile SSB installation. This was modified for inclusion in a piece of gear recently described in *CQ*[1]. Since then, inquiries have been received regarding the installation of the IFNL, itself, directly in the 75A4, so a model was hastily constructed for this purpose. Cost?—$2.50!

The circuit of the IFNL is shown in fig. 1. Its operation was discussed in the previous article, but it is repeated here for those who may have missed the original description.

Two diode sections of the 6AL5 are connected in a full-wave arrangement in shunt with the *if* amplifier output circuit (at secondary of *T3*), and thus it functions at the *if* frequency, making it an *if* type of noise limiter. The diodes are selfbiased by the rectified potential developed across R1. The time constant, resulting from the combination of R1 and coupling capacitors C1 and C2, is such that the bias varies almost at a syllabic rate with an SSB signal. This minimizes diode conduction, tends to prevent any limiting action, and so allows the signal to pass on practically unhindered. But when a short steep-fronted noise-pulse is received, the self-bias at this instant cannot rise rapidly enough to prevent conduction, and the amplitude of the noise pulse is then limited by the action of the diodes.

The diode action of the IFNL is more like that of a variable load resistor functioning as a compressor across the circuit rather than as a shunt clipper. As such it does not develop the same distortion as is experienced with the conventional audio type noise limiters wherein the signal-peaks, as well as the noise-peaks, are clipped off thereby producing square waves which result in high audio distortion. Because of the self bias which is developed when an SSB signal is received, little limiting of the signal is found with the IFNL, except at the first impulse of a syllable, usually at the start of a word, or in the case of a CW signal it will occur at the start of each keyed character. Nevertheless, a small amount of distortion may be noticed, because the compression action of the IFNL is somewhat non-linear. In addition to this a hang-over effect, due to the time delay of the R/C circuits, can produce a characteristic which sounds like slight distortion. The extent of these effects depends on the values selected for R1, C1 and C2. Regardless of this, the distortion for a given amount of noise silencing is less than that experienced with conventional CW and SSB noise limiters, and the readability of weak signals under adverse impulse-noise conditions excells that possible with present CW or SSB noise limiting devices.

The IFNL can be effective only when it is

[1] "20 KC Filter Adapter and SSB IF Noise Limiter for the 75A4," *CQ*, April, 1960.

connected across a relatively high impedance circuit which works either out of, or into another high impedance circuit. It is also necessary that a fairly high *rf* potential be available at the source (2 or more volts). Installation of the IFNL across the secondary of the last *if* transformer (T3), as indicated in fig. 1, is the only suitable point in the 75A4 which satisfactorily meets these requirements.

The inherent loading presented by the IFNL (this is mostly dependant on the value of R1) is such that a small loss in level may occur when it is in use, so when the noise limiter is taken out of operation by means of SW1, an equivalent load resistance, R2 is switched in its place to equalize the signal level at either position of the on-off switch.

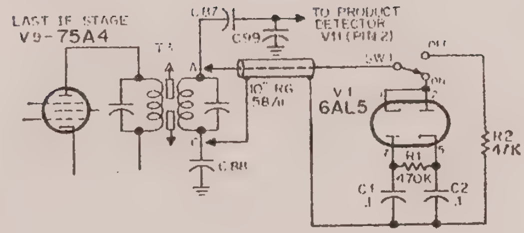

Fig. 1—Circuit of the SSB IF Noise Limiter. The IFNL connects permanently across points A and C of T3. While designed for the 75A4 it may be used with other receivers.

Construction

The SSB *if* noise limiter is built in a small Bud Minibox, 1⅝" x 2⅛" x 2¾". The location of holes and dimensions are given in fig. 2. A pictorial wiring diagram is also shown at fig. 3. No special wiring precautions are necessary, except do *not* ground the shield of the output cable which is used to make the *rf* connections to the 75A4. The output cable and two separate heater leads (ground and hot 6.3 *vac*) should be brought out through hole F.

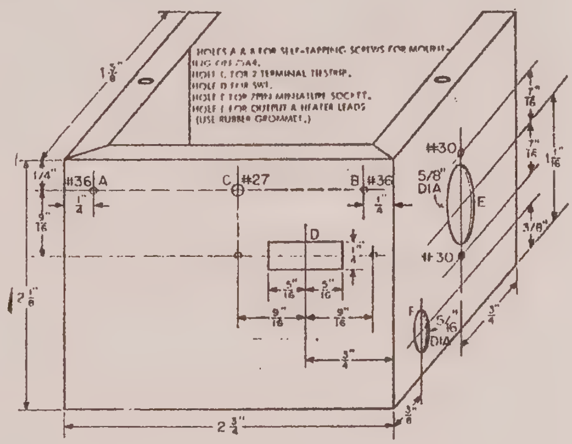

Fig. 2—Location and dimensions of holes for the construction of the IFNL.

Installation and Operation

After the unit has been completed it may be fastened to the right side of the 75A4 by means of self tapping screws (inserted in holes A and B). These are passed through the ventilation slots of the cabinet after a large washer is placed on each screw to prevent its slipping through the slot. See fig. 4. The location of the components is such that the on-off switch will automatically fall in line with one of the slots and protrude through it. The leads from the IFNL should pass through a 5/16" diameter hole which must be drilled in the 75A4 chassis between T3 and V11. Connect the heater leads to the nearest ground and 6.3 *vac* point. Connect the shield of the coax output lead to terminal C of T3 or to the diode test terminal. Be sure the shield lead does not touch any grounded point. Connect the inner conductor of the coax lead to terminal A of T3.

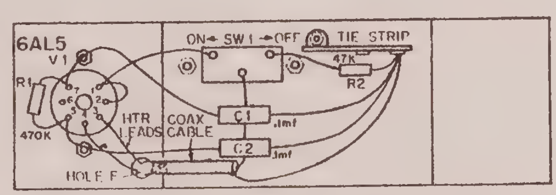

Fig. 3—A pictorial wiring diagram of the IFNL. The wiring it not particularly critical.

Set up the 75A4 for SSB reception without any antennas being connected to it. Place the IFNL on-off switch at off. Set the 75A4 Limiter at off, and adjust the *rf* and *af* gain controls until background noise can be heard. Tune the secondary slug of T3 (at bottom of chassis) counter clockwise for maximum background noise. Then check the IFNL switch by placing it at on, at which time the background level should drop.

Now, connect the antenna, place the IFNL switch at off and tune in an *ssb* signal. Then place the IFNL switch at on, and note the audio signal level which should drop only slightly from that found with the noise limiter out. Do not use receiver background noise for

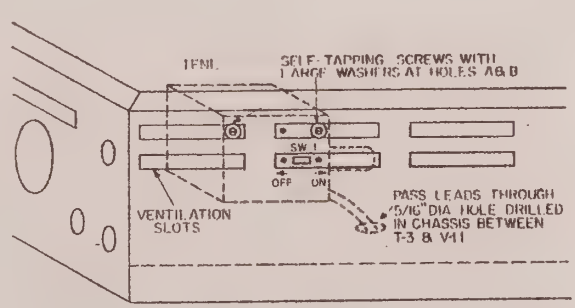

Fig. 4—How to mount the IFNL in the 75A4. Large washers are used to prevent the screw heads from dropping through the ventilation slots.

checking relative levels because the IFNL inherently drops the noise level anyway. The values of R1 and R2 have been selected for generally good impulse-noise limiting action and audio level equalization for use with the 75A4, but in some cases it may be desirable to change these. If the audio level drops too much when the IFNL is switched on, R2 may be reduced for equalization. If more limiting action is required, R1 may be reduced, at which time R2 will also have to be reduced to maintain equalization of level. In cases where extremely high noise impulses are likely to be encountered, the installation of a .1 or .22 mfd capacitor across *R1* will further enhance limiting action, although the hang-over effect, mentioned earlier may be more noticeable due to the time constant increase.

It may be noticed that when the noise limiter is used, a background hiss may be detected which was not heard before. This background effect actually *was* there before, but its presence was masked out by the prevailing noise conditions.

Since the IFNL is connected in the *if* amplifier, it may be used to advantage for limiting noise pulses which may otherwise effect the *avc* system sufficiently to cause a reduction of receiver gain during a train of noise pulses. The *avc* system in the 75A4 is connected ahead of the last *if* stage, so it would then be necessary to disconnect the *avc* amplifier feed from L27, and connect it to pin 2 of the product detector V11 through a small capacitor of a value which would normalize the *rf* gain through the *avc* amplifier. This was not done in the author's case, since existing noise conditions did not require it.

The 75A4 is notorious for its hard *avc* attack and popping at the start of a word, but since the IFNL tends to limit the amplitude of the initial impulse at the start of a word, it will soften the attack, and will virtually eliminate these unpleasant effects even when the *rf* gain is wide open with full *avc* action.

For CW reception the INFL will be found very effective for impulse-noise suppression and for the reduction of key-clicks. As mentioned previously, CW signals also will be softened at the start of each keyed character due to the instantaneous impulse-noise limiting action of the IFNL. It may also be noticed that the noise pulses tend to "ride in" on the *dash* of a CW signal as the bias builds up sufficiently to minimize limiting during this period. This is a characteristic similar to that experienced with conventional AM noise limiters where the limiting action decreases as the strength of the carrier increases; however, if the CW signal is strong enough to accentuate this effect, its readability will not be hindered anyway.

The IFNL is not as effective during AM reception as is the 75A4 noise limiter, nor is it as good as other types for this mode, so its use is not recommended in conjunction with AM reception.

Use With Other Receivers

The SSB *if* noise limiter, described herein, has been constructed specifically for installation in the 75A4 receiver. However, it may be effectively used with other receivers, and at any other *if* frequency if the circuit impedance and operating potential requirements are met as specified earlier. In addition, another requisite is that no *bfo* potential appears across the circuit to which the IFNL is connected. Such a potential will be rectified by the diodes, and thus will create a fixed-bias which will render the IFNL useless (this is also the reason why many conventional limiters are not effective for CW and SSB use). Detrimental *bfo* potential usually will not be encountered if a good product detector is used, and if the *bfo* circuits are well isolated to prevent stray leakage. The IFNL will be ineffective when the *bfo* potential is injected at the *if* transformer, as is usually done when a conventional diode detector is employed.

In most cases the best installation point will be at the output transformer of the last *if* stage, as long as the *bfo* potential is not present. If a "signal slicer" is being used with the receiver, the IFNL should be effective when it is installed across the primary or secondary of the receiver's *if* transformer to which the slicer is connected. If the secondary is chosen, it may be necessary to insert a 10 mmf capacitor between the transformer terminal and the connection which feeds the slicer. In any case, the best point of installation in a particular receiver may be subject to some experimentation.

Coupling capacitors C1 and C2 may be reduced in size as the *if* frequency is raised, as long as their reactance is about 200 ohms or less. If this is done, the time constant will have to be restored by the addition of the required size capacitor across R1. In general, the values of R1, C1 and C2 will be satisfactory for use with other receivers, but R2 probably will have to be altered to equalize the level at the separate on-off settings of the switch, as described aforehand.

Unfortunately, the IFNL cannot be successfully used with the KWM-1, because the latter has too much stray *bfo* leakage which appears at the points where the IFNL would have to be connected in the *if* system ahead of the product detector. It has been effectively used on an old SX-24 using a product detector, and on several home-built receivers using *if* frequencies of 50 and 20 *kc*. It has also been extremely effective in a mobile SSB installation which employs a broadcast ARC-5 receiver (*if* frequency, 265 *kc*) as the variable *if* system behind a crystal controlled converter. Although the circuit arrangement is slightly different in this case, it is equivalent to changing C1 and C2 to .01 mf and adding 1 mf across R1.

[*Continued on page 119*]

for maximum grid drive to their respective circuits. If at first the circuits are considerably out of resonance, they may be tuned by peaking L_1 for maximum output on twenty meters and L_2 for maximum on ten meters while listening on a receiver. Once these adjustments have been made, only tuning of the final will be necessary when changing frequency due to the relative broad banded characteristics of the circuits. With an antenna or dummy load connected, C_{11} is tuned for maximum current, C_{10} is tuned for a "dip", and the process repeated until the desired loading is attained (about 50 milliamperes).

Conclusion

This installation has proven quite successful for the operations of "W5TBC Mobile", for local "rag chews", operation on the RACES net and regular contacts with more distant stations. Although no "rare DX" has been worked, very good reports have been received from contacts with stations on both the east and west coast areas while in operation on highways in the north and central sections of Texas. Rather than being the ultimate in a mobile "rig", it is a compromise between the minimum amount of equipment and the more costly installations which supply more flexible and higher power operation. Many miles of road have been traveled and the log books shows many hours on ten meter phone with numerous contacts. The small investment in time, effort and cost of parts has been repaid by satisfaction in "going mobile the easy way". ■

IFNL [*from page 44*]

Most impulse type of noise interference is due to automobile ignition systems and similar electrical devices wherein the pulses are steep sided ones of very short duration. Noise interference from sources such as power leaks, fluorescent lights, etc., may be due to pulses which are quite long in duration and which run together, drawn out into a continuously overlapping train, in which case the effectiveness of *any* impulse-noise limiter will be reduced. Thus any *one* type of noise silencer is not necessarily a cure-all against *all* types of noise interference.

It has been shown elsewhere[2] that impulse-noise suppression can be more effective when it is applied at a point ahead of high Q or highly selective circuits. Unfortunately, the available *rf* operating potential at a point ahead of the selective filter system in most SSB receivers is too low to satisfactorily operate the IFNL. Nevertheless, even though it must be installed at a point further on in the receiver, it does an exceptionally effective job of impulse-noise suppression with excellent SSB signal intelligibility. ■

[2] Collins Instruction Manual for 75A4.

More On The "IFNL"

Wilfred M. Scherer, W2AEF

The author answers some questions regarding the "IFNL", an s.s.b. i.f. noise limiter which is gaining popularity. Its installation in the 75S-1 receiver is also covered.

As was expected, quite a number of inquiries have been received regarding the operation and installation of the *IFNL*, the s.s.b. i.f. noise limiter recently described in *CQ*[1]. Since many of these inquiries were of a similar or duplicate nature, it is likely that other readers may be concerned about the same situations, so the questions are enumerated and discussed as follows:

1. *Question:* The *IFNL* does a fine job of noise limiting on my such-and-such a receiver, but there is quite a loss of level when it is used. Can this loss be reduced?

Answer: Yes, the insertion loss may be reduced by increasing the size of R_1 to about 2 megohms. This will also reduce the degree of limiting, but this may be substantially offset, if needed, by the addition of a capacitor across R_1, which may be .02 to 1 mf, depending on the desired action. See the two following answers.

2. *Question:* May the degree of limiting be made adjustable by varying R_1?

Answer: Yes, R_1 may consist of a variable resistor of two or three megohms connected in series with a fixed resistor of 270,000 or 470,000 ohms. This will enable the *IFNL* to be adjusted for different degrees of limiting. When a minimum amount of resistance is used, the limiting action will be maximum, while the maximum amount of resistance will result in minimum limiting. The level of insertion loss, caused by the *IFNL*, will be less at the higher values of R_1. A fixed value of 470,000 ohms was used in the model for the 75A-4, since in general this provided good limiting action under quite severe noise conditions, and no need for changes in the degree of limiting were required. An additional control was also thereby eliminated.

3. *Question:* The *IFNL* works fine, and it permits good signal readability through ignition noise, but it would be better if the distortion could be lowered. Can this be done?

Answer: Yes, the distortion may be reduced by increasing the size of R_1 to about 2 megohms, and/or by decreasing the total capacitance across R_1, which in figs. 2 and 3 is

$$\frac{C_1 + C_2}{4} + C_3$$

The limiting action will be reduced at the same time, but it still should be effective for average conditions. The constants, which were used in the 75A4 installation, were chosen to cope with heavy noise pulses—those which kicked the S-meter to around S-9.

There are two types of distortion which may be experienced. One is dependent on the size of R_1, and is indicated when the demodulated s.s.b. signal sounds rough or growly, especially at the lower audio frequencies. Such distortion is low when R_1 is large, about two or three megohms. Both distortion and limiting action increase as R_1 is decreased.

The other type of distortion mainly is dependent on the total capacitance across R_1, and is evidenced by a fuzzy sounding, or paper-like, tail following each s.s.b. syllable. This effect is most noticeable when the capacitance is large, but impulse-noise softening is also better at the same time. Actually, this "tail" distortion is due to the R/C time constant, but since R_1 must primarily be selected for the desired limiting threshold, the capacitance must be selected secondarily in regards to this type distortion.

Each element (R and C) works against the

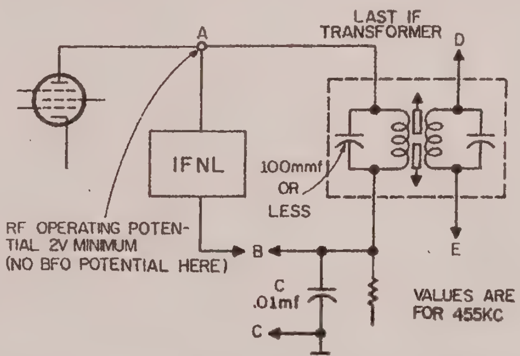

Fig. 1—Three different methods of connecting the "IFNL." Normal connections for the "IFNL" at A and B. If "C" is at least .01 mf the "IFNL" may be connected to points A and C. The "IFNL" may be connected to points D and E if the transformer is working into a high impedance.

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[1]Scherer, W.M. "IFNL An SSB IF Noise Limiter", *CQ*, June, 1960 p. 42.

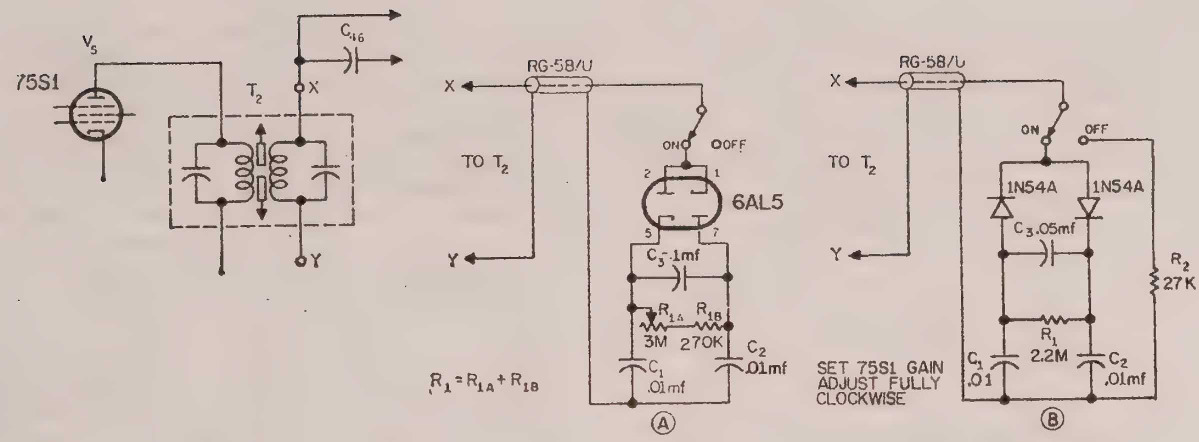

Fig. 2—Two methods of constructing the "IFNL". Both vacuum tube and crystal diode methods are discussed in the text. In both cases they connect to points X and Y of T_2 of the 75S1.

other. So the final selection of values for these components must be a compromise resulting in the maximum tolerable overall distortion for the degree of noise limiting action which is required under the generally prevailing noise conditions. A certain amount of flexibility in this respect may be obtained by making R_1 variable. See *Answer #2*. This will provide a reasonable degree of latitude in the control of distortion *vs* limiting action. Also, if $C_1$and C_2 are each made .01 mf, the best value of total capacitance may readily be determined by trying different size capacitors across R_1, later permanently wiring-in the one which gives adequate limiting and low "tail-distortion" over the range of R_1. See figs. 2 and 3. In addition to making R_1 variable, an all-out arrangement would be to add a switch for the selection of various size capacitors at C_3.

4. *Question:* Can crystal diodes be used in place of the 6AL5 in the *IFNL?*

Answer: Yes; in fact, they do a better job in cases where the maximum available r.f. operating potential at the r.f. transformer is only 2 or 3 volts, because in such a case the r.f. potential will be too low to sufficiently overcome the contact potential of vacuum tube diodes, with limiting action thereby being impaired. This is the reason why crystal diodes were installed in the *IFNL* used with the 20 *kc* filter adapter described earlier in *CQ*[2]. If crystal diodes are used, they should be the high back-resitance type such as the 1N54A, 1N67A, etc. Select those with a back resistance of at least 1 megohm. This may be checked with a 20,000 ohms-per-volt volt-ohmmeter. *Caution:* Do *not* measure crystal diode resistance with a v.t.v.m.! The crystal diode resistances are lower than those of a 6AL5, so the minimum degree of limiting cannot be reduced further by increasing R_1 beyond about 2 megohms. Also, the insertion loss may be higher than when a 6AL5 is used.

5. *Question:* Will the *IFNL* work when it is installed across the primary, instead of the secondary, of T_3 in the 75A-4 receiver?

Answer: Yes, but its effectiveness will be limited due to the relatively lower impedances on the primary side. It is far more effective when it is installed across the secondary of the transformer in this case, because the secondary impedance conditions are more favorable.

6. *Question:* Can the *IFNL* be made to work with a.m. signals?

Answer: Yes, but it is not effective for this mode of operation as are other a.m. noise limiters, especially the *TNS*. For a.m., R_1 will have to be increased to several megohms to avoid high distortion which would otherwise result with a.m. signals.

7. *Question:* Since noise pulses are integrated and lengthened when they are passed through highly selective circuits, would it not be better to install the *IFNL* ahead of the sideband filter?

Answer: Yes, if the r.f. operating potential at such a point is high enough, but unfortunately this seldom is the case. A minimum of about 2 volts r.m.s. is required as set forth in Answer #4. This was also discussed in the original article.

8. *Question:* Is it necessary to shield the r.f. leads to the *IFNL?*

Answer: No, but if the leads are fairly long, the chances of feedback causing i.f. amplifier instability, and of b.f.o. signal pickup which would limit the effectiveness of the *IFNL*, are minimized when shielded leads are used. This will vary with individual installations and different lead lengths. Unshielded leads have been quite satisfactory in many installations.

9. *Question:* When the *IFNL* is installed, may the bottom leg of the circuit be connected to ground instead of to the bottom end of the i.f. transformer winding?

Answer: Yes, if the bottom end of the transformer winding is bypassed with at least .01 mf (at 455 *kc*). See fig. 1. This method, however, is not recommended if crystal diodes are used in place of the 6AL5. The instantaneous surge of the B plus potential through the capacitors, C_1 and C_2, when the *IFNL* is switched on, will eventually damage the crystal diodes.

[2]Scherer, W.M. "20 KC Filter Adapter and SSB Noise Limiter for the 75A4", *CQ*, April, 1960, p. 32.

10. *Question:* May the values of C_1 and C_2 be reduced?

Answer: Yes. This was covered in the original article. With an i.f. of 455 *kc*, C_1 and C_2 may be reduced down to .01 mf as shown in the accompanying diagrams. The time constant will have to be restored by adding a capacitor (C_3) across R_1. This capacitor should be about .05 mf. See *Answer #2*.

11. *Question*: It is understood that the *IFNL* may be disabled by using a switch to disconnect one end of R_1. Is this correct?

Answer: When a 6AL5 is used, from a practical standpoint, the answer is yes; however, the limiting action may not be *completely* removed in some cases. When crystal diodes are used, the *IFNL* cannot be satisfactorily disabled by opening one end of R_1. This is due to the comparatively lower back resistance of crystal diodes.

12. *Question*: How should the *IFNL* be installed in the 75S-1 receiver?

Answer: It may be connected across the primary or secondary of T_2 (the latter is better), but its effectiveness will be limited due to the low r.f. operating potential experienced at these points (about 2 volts). See fig. 2a.

The use of crystal diodes in place of the 6AL5 will do a somewhat better job when the *IFNL* is connected to T_2 but its maximum possible effectiveness still will not be realized, and there will be a noticeable loss in signal level which must be restored by advancing the r.f. gain control (R_{57}) in the 75S-1 fully clockwise. See *Answer #4* and fig. 2b.

The best arrangement for the 75S-1 is to substitute a higher impedance i.f. transformer for T_2, and then connect the *IFNL* across its primary winding. See fig. 3. This will provide better impedance relations and a higher r.f. operating potential for good effectiveness of the *IFNL*. The selectivity will not be impaired by the new transformer, because this is primarily controlled by the characteristics of the mechanical filter.

With any of the above arrangements, the *IFNL* components may be mounted on a plate installed on the chassis in the space which has been set aside for the noise blanker. A shield should be mounted along the front bottom edge of this plate to isolate the *IFNL* from the mixer and front end of the i.f. system. Insulated shielded leads (coax, RG-58/U) should be used to make the connections between the *IFNL* and the last i.f. stage circuits. If T_2 is replaced in the circuit by a higher impedance transformer (T_2a), the former need not be physically removed from the chassis. The new transformer may be mounted on the plate with the *IFNL*. The ON-OFF switch may be attached to the rear of R_1a. The shaft of R_1a should be left long, so that it extends far enough above the chassis to allow it to be easily reached and operated. R_1a also may be mounted on the front panel between the phone jack and the emission switch. The space will be found to be too tight to include the switch as well as the potentiometer. In this case, the switch may be left out by making R_1a

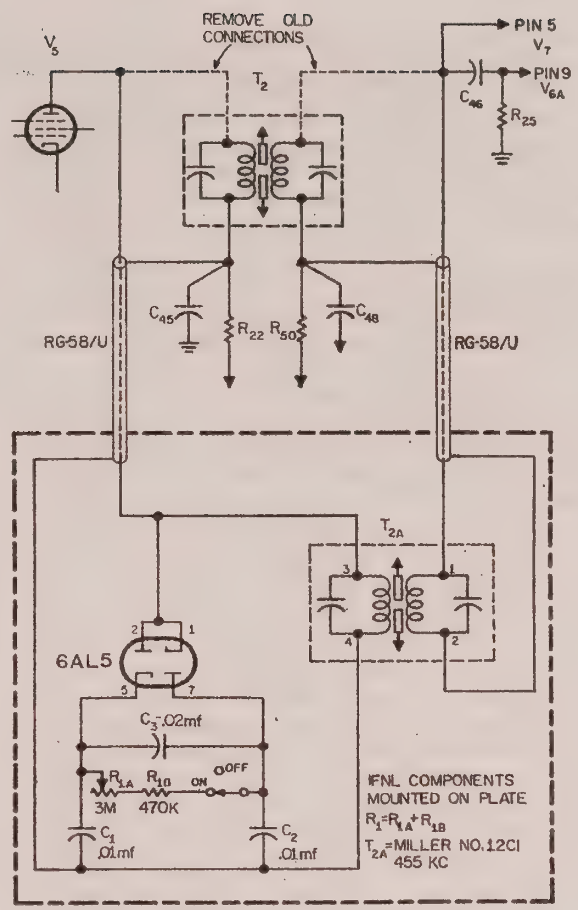

Fig. 3—By substituting T_2a for T_2 in the 75S1 a better impedance match is attained and higher r.f. potential is obtained for better effectiveness of the "IFNL".

ten-megohms, at which setting the *IFNL* will be sufficiently disabled when its use is not required. Shielded leads should be used to the potentiometer with their shields grounded.

When the crystals diodes are used, as in fig. 2b, the insertion loss will be higher than when the arrangement at fig. 2a is used. A 27,000 ohm resistor, R_2, is switched in to provide a similar loss when the *IFNL* is switched out, thus eliminating large level changes when the limiter is switched on and off. When R_1a is set at maximum resistance in the arrangements of fig. 2a and 3, loss equalization is not required. If however, conditions most of the time are such as require R_1a to be set near its minimum value, (at which time the loss level is higher) it may be desirable to add loss equalization as shown in fig. 2b with R_2 chosen for the needed equalization.

If only 6 volt operation of the 75S-1 is contemplated, the 6AL5 heater leads may be connected between ground and the hot 6.3 volt terminal on the tie-point strip to which the v.f.o. cable is connected. For universal operation (a.c. 6, 12 and 24 volts) connect the 6AL5 heater leads to terminals 3 and 4 on the V_5 socket. Then the power-plug connections should be as follows: (Refer to the 75S-1 schematic)—

For a.c. and 6 volt operation, no change; for 12 volt operation, connect the 47 ohm resistor to pins 10 and 11 instead of pins 9 and 10; and for 24 volt operation, connect the 47 ohm resistor as described above for 6 volt use, and also connect a 39 ohm resistor to pins 3 and 9.

Alignment

The alignment procedure is as follows: After the IFNL has been installed, turn the 75S1 operating switch to CALIBRATE, the emission switch to LOWER or UPPER SIDEBAND, the *IFNL* switch at ON, the *IFNL* threshold control, R_1a, at maximum resistance (minimum limiting), and tune the receiver to 14.2 *mc* for a beat note of a little over 1000 cycles. Adjust the tuning slugs in T_2 or T_2a (depending on which circuit is used, fig. 2 or 3) for peak signal as indicated by the S-meter. As the signal level is peaked above S-3, detune the PRESELECTOR TUNING for readings near S-3, because signal levels at this point will give sharper and more accurate peak readings than those made near the S-9 region. Then switch out the *IFNL*. The S-meter reading should remain nearly the same, but if it does not, it may be corrected by changing the equalizing resistor R_2, or by adding such an arrangement if desired. If fig. 3 were used with the switching arrangement of fig. 2b, it would be necessary to add a small trimmer capacitor across R_2 to restore circuite resonance when the *IFNL* is switched out.

Since the *IFNL* is installed ahead of the a.v.c. system, it will deter trains of noise pulses from activating the a.v.c. and desensitizing the receiver during such periods. It will also minimize annoying momentary loss of receiver gain during occasional heavy pops of noise. It may also be noted that the S-meter does not kick up quite as readily when the *IFNL* is used. This is due to the impulse limiting action of the *IFNL*.

Other Questions

Other questions dealt with the installation of the IFNL in different specific receivers; however, it would involve too much to include all these at this time. The data for the 75S1 was included herein, because this was, by far, of the most concern.

The three different circuit arrangements, shown herein, also indicate the various possibilities in values and switching which may be used in connection with other installations. R_1 is also shown as a variable, since it is apparent that most operators just must have an extra control with which to diddle. Another arrangement, for varying the degree of limiting, will be found elsewhere in this issue of *CQ*. An advantage gained with this method is that the basic time constant does not change as the degree of limiting is varied. On the other hand, when a low-e i.f. transformer is used, such as in fig. 3. The circuit resonance will vary at the same time.

The preceding information, plus that given in the original articles, should be sufficient to cover most other situations. In general, the best installation point will be found to be across the primary of the last i.f. transformer. See fig. 1. Also, remember that an important requisite is that the absence of a b.f.o. signal, at the point of installation, is essential. Such signal may be picked up directly from the b.f.o., or it may get through to the front end of the i.f. strip, and thereby be amplified by the time it reaches the i.f. output. This will require good b.f.o. shielding and well isolated leads, with careful selection of ground-return points in the circuits concerned. When shielded leads are used to connect the *IFNL*, realignment of the i.f. transformer will be required. ■

Statement of Ownership

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 AND JUNE 11, 1960 (74 STAT. 208) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION of CQ—THE RADIO AMATEUR'S JOURNAL, published monthly at New York, N. Y., for October 1, 1960.

1. The names and addresses of the publisher, editor and business manager are: Publisher: Sanford R. Cowan, 6 Embassy Court, Great Neck, N. Y.; Editor: Arnold Trossman, 300 West 43rd Street, New York 36, N. Y.; Managing Editor: none; Business Manager, Richard A. Cowan, 6 Embassy Court, Great Neck, N. Y.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address as well as that of each individual member must be given.) Sanford R. Cowan, 6 Embassy Court, Great Neck, New York.

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5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required by the act of June 11, 1960 to be included in all statements regardless of frequency of issue.) 36,498.

(Signed) Richard A. Cowan, Business Mgr.

Sworn to and subscribed before me, this 15th day of September, 1960.

HERBERT PARISER, Notary Public
(Commission expires March 30, 1961)

the rabid enthusiasts) and for fixed frequency clear channel high power commercial point-to-point service it has no peers. *But* for all but the DX hunting, certificate collecting *etc.*, it has some distinct shortcomings. Consider for example, the short haul rag chewer (who comprises probably most of the active amateurs). He works away at his latest project meanwhile monitoring the favorite frequency of the group he habitually talks to—this will normally be the local 75 meter net but could be anything. On a.m. he can cover a lot of conversations ignoring those of little interest until something comes along that perks him up. Voices are instantly recognizable even when far off frequency. But on s.s.b.—what a hope!

"The big feature is let's not have any more legislating for the ham bands. There should be a *minimum* of restrictions. It is (on our Canadian licenses anyway) designated as an Amateur Experimental Service and as such it should not be restricted except in so far as is absolutely necessary to prevent monopoly by a minority (which is what our s.s.b. 'friend' is advocating). Instead of his banning everything but s.s.b. let us remove all present restrictions as to mode but introduce as the only restriction that the radiated power be a maximum of 1000 watts (although I would prefer it personally to be 100 watts!) with no radiations over a −70 db level (or 250 milliwatts, whichever is the lesser) measured not closer than plus or minus 5 kc to the center of the radiated signal. In other words, you can use any mode you want provided it does not occupy more than 10 kc of the spectrum.

"Rather than saying that s.s.b. is the only mode to use, amateurs should be trying any and all methods of communication. For example, I have never been persuaded that n.b.f.m., using modern techniques for reception, hasn't many advantages expecially for local net type operation. Also where would c.w. and RTTY fit into this?

"It could be the item was intended for humor. If so, let's have less of this and a return to the wide open experimental service. Let's get those empty 'c.w.-only' portions of the spectrum filled with amateur experimenters and less of a 'one-type-only' and that mostly 'commercial' type of deal."

"Vince", VE1AGT
RCAF Station, Sydney, N.S.

Our opinion? If every a.m. station switching over to s.s.b. would continue to operate on the same frequency used before the switch we'll bet that it won't take fifteen years!

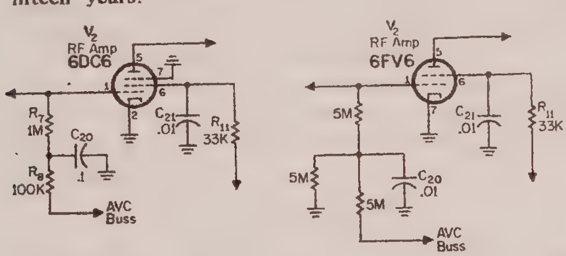
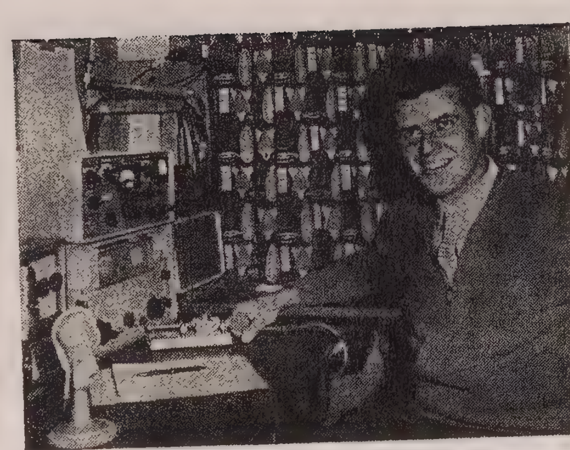


Fig. 1—Modifications to the r.f. amplifier of the 75A-4. Change the 6DC6 to a 6FV6 and make the grid grid circuit changes shown.



Meet Gody Stalder, HB9ZY, of Meggen-Lu, Switzerland, whose compact station fills a neat little corner in his home.

Up date the 75A-4

Every now and again the venerable 75A-4 pops back into the news with a modfication to improve it's operating abilities.

Earl Lucas, W2JT, much respected for his ability to improve ham gear, has come up with several changes in the circuitry of the 75A-4 which we are happy to pass along. Earl is the type of fella' who cannot accept any circuit as being the final and best way of doing a job. If he can squeeze a fraction of a db more out of a received signal, Earl is there with the soldering iron.

One department in which the 75A-4 has been in need of some help is the audio section. Although quite adequate for communication purposes, it leaves something to be desired in the quality department. Modifications needed to improve the audio are quite simple. Remove R_{71}, 33K from V_{13} and replace R_{109}, 390K with 750K.

For greater i.f. gain, remove R_{40}, 22K from across L_{27} and remove R_{20} from across L_{24}. These changes are not new and have been tried previously with inconclusive results.

The change of the second mixer from a 6BA7 to a 6U8A as outlined in our column in June 1960 is worthwhile and we can recommend this modification from our own experience. If the mixer changes are not contemplated, check screen voltages on the 6BA7 mixers. They will probably show 150 to 170 volts. Tube manufacturers maximum ratings are 100 volts. Increase the values of the screen dropping resistors to get 100 volts. As for the other suggestions, we have not as yet had the opportunity to try them and we must reserve comment until such time as we have. A number of technically well-versed hams have, however, made these changes and their experiences suggest that they have improved the receiver as anticipated.

Sideband To The Rescue Again

On August 14, 1962, the son of the Honduran Ambassador to San Salvador was critically injured by an

[*Continued on page 174*]

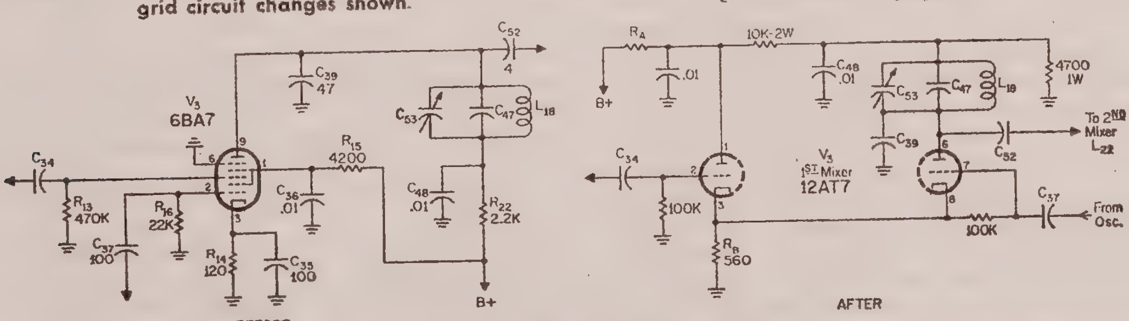
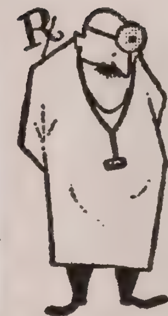


Fig. 2—Improved first mixer circuit for the 75A-4. First mixer is changed from a 6BA7 to a 12AT7 with the circuit changes shown. Resistor R_A is adjusted for 150 volts on pin 1 of the 12AX7. Resistor R_B can be between 100 and 1000 ohms with varying results



HAM CLINIC

CHARLES J. SCHAUERS*, W4VZO

THE perfect radiator of r.f. energy has never been invented, nor is it ever likely to be. However, some of the letters received by HAM CLINIC indicate that we have many hams who think that merely by having the correct amount of installation space and money, one can come up with an antenna that radiates every bit of generated r.f. energy in a desired direction. But this is not true.

If every bit of r.f. energy could be concentrated into a very narrow beam (as it is in the LASER) and it would not be affected by the terrain over which it passes, all signals would be S-9 + 60 db! But this is impossible!

What every ham wants is a good *practical* antenna system which radiates as much of his generated r.f. power as possible and theory be derned! But before any ham can be fully satisfied (he like those before him) must try out a number of antennas before he settles on one which pleases *him.*

To the queries from HAM CLINIC readers who ask, "is the Brand "X" vertical better than Brand "Y"?", we say, if they are in the same price class, the difference will be negligible. You get what you pay for—make no mistake about this. On the other hand, the slogan, "ask the man who owns one" is not the best assurance of obtaining the article which will suit you; for he may be satisfied with much less than you are willing to settle for.

Questions

Stacked "V" Beam—"How much more gain has the stacked V beam antenna as compared to the single V?"

The stacked V has about twice the gain as its single brother (about 3 db more).

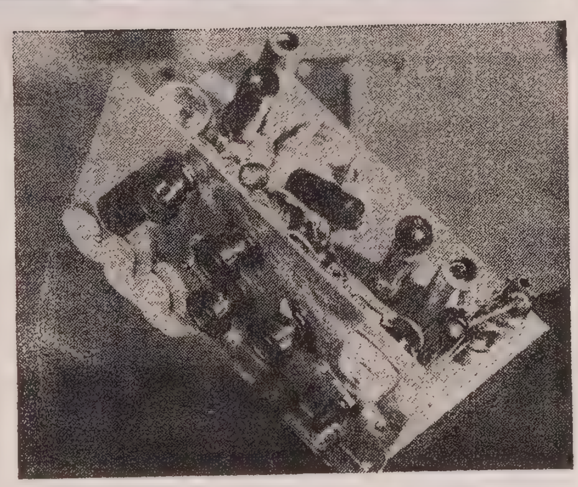
V.h.f. Antenna Length—What is the formula for figuring the length of a half-wave antenna in the v.h.f. region?

For construction purposes, this formula:

$$\text{Length (inches)} = \frac{5540}{F\ (\text{mc})}$$

will suffice. The formula takes into account the end effect or the changed ratio of diameter to element length.

Adapt-O-Citer Winner—The first picture we have received of a completed and working Adapt-O-Citer constructed from information in the Special HAM CLINIC issue of *CQ* (June 1962) was submitted by VE2BCT Jean Treskin of Pont-Viau (Montreal). Jean says others in his area are building the 'citer, for a first try at s.s.b.



VE1BCT's version of the Adapt-O-Citer which appeared in CQ for June 1962,—the special *Ham Clinic* issue.

A buffer stage and v.f.o. was added to the 'citer. A 6DQ5 final is now under construction. He completed the unit for only $22!

Congratulations Jean and thank you so much!

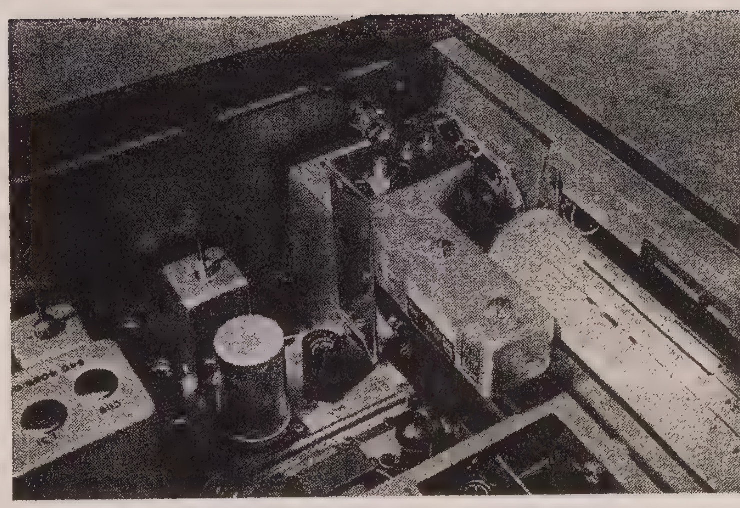
75A-4 Receiver Improvements—Now and then, we receive mail from hams like "Cap" Frazier, W4TAI who offer technical tid-bits of general interest to all hams. This time he has compiled (from experience) worthwhile improvements for the 75A-4 receiver. Thanks Cap.

Replace V_5 the 2nd mixer which was originally a 6BA7 and substitute a 6U8A to obtain a lower noise figure. A little rewiring is necessary but is worth the effort. Replace V_2 the r.f. amplifier (originally a 6DC6) with a 6BZ6. Better sensitivity is realized. No rewiring is necessary. Just substitute. Replace V_{17}, a 5Y3 with a silicon diode rectifier combination to reduce heat. TAB has the inexpensive unit. S.s.b. and c.w. reception will be improved and more i.f. gain obtained by simply removing one end of resistor R_{46} which is across i.f. transformer L_{27}. This resistor is used to de-Q the i.f. transformer and its removal very slightly degrades a.m. but the additional peaking attainable with its removal is worth the trouble. The side-tone monitoring signal of the Collins S-line or Heath Marauder can be

[*Continued on page 94*]

*c/o *CQ*, 300 W. 43 St., New York 36, N. Y.

Fig. 1—Here is the filter assembly installed in the Collins 75A-4. It plugs into the V-7 socket in the receiver. The shaft of the selectivity switch, S_1, is carried out through a slot in the end of the receiver case, using a universal-joint shaft coupler and a panel-bearing assembly. Note that all adjustment points are readily accessible.



Improving the C.W. Selectivity of the Collins 75A-4

An Easily-Applied Crystal Filter

BY BRUCE E. MONTGOMERY,* W4BFR

The need for a high order of c.w. selectivity on the amateur bands is obvious to all who do more than casual operating. The 500-c.p.s. mechanical filter in the Collins 75A-4 receiver provides sufficient selectivity to cope with many interference conditions, but there are still times when a 500-c.p.s. passband seems mighty wide. For example, FB8XX and ZD9AM were recently heard working contest-style simultaneously on 7001 kc. and 7002 kc., respectively.

Old-timers will remember when communications receivers achieved high selectivity with a quartz crystal filter using a single crystal at intermediate frequency in a bridge circuit that made use of the series resonance and high Q of the crystal to provide a high degree of selectivity at the peak, but depending on several i.f. transformers to give skirt selectivity. This is in contrast to modern mechanical filters that have a flat-topped selectivity curve with steep sides and good skirt selectivity.

The plug-in crystal-filter assembly described here is of the old-fashioned variety, and adds its sharply-peaked selectivity to the steep-sided mechanical-filter selectivity. The result is a sharply-peaked response with steep sides and improved skirt selectivity, since the crystal filter does add some worthwhile attenuation at the skirt of the selectivity curve. The following table shows the narrowing of the selectivity curve at the 6-db. and 60-db. points in the crystal-filter No. 1 and No. 2 selectivity positions.

The first column shows the selectivity of the F455J-05 mechanical filter alone. A word about these selectivity figures is in order. The data on the 500-c.p.s. mechanical filter is the manufacturer's published specification information. More exact data is given later. The data with the crystal filter in the circuit was taken by careful reading of the 75A-4 kilocycle dial and S meter, so this is subject to some reading and calibration error.

Table I

Decibels Down from Maximum	*Crystal Filter Position — Bandwidth in Kc.*		
	Off	*No. 1*	*No. 2*
6 db.	0.5	0.14	0.09
60 db.	2.0	1.5	1.3

The crystal-filter assembly plugs into the V-7 socket, which is for the 12AX7 slot-rejection tube. The 12AX7 plugs into the assembly and the rejection tuning continues to operate normally. A 6BA6 i.f. tube is added in the assembly to make up for the insertion loss in the crystal-filter circuit. The amplification of this stage is adjusted to produce 0-db. gain when the crystal is out. The gain drops less than 3 db. in the No. 1 position and about 6 db. total in the No. 2 position. This loss of gain is of no consequence since the 75A-4 has ample reserve.

The addition of this adapter results in a combination of the high "nose" selectivity of the crystal filter and the skirt selectivity of the mechanical filter.

*6520 Bridgewood Valley, N.W., Atlanta 5, Georgia.

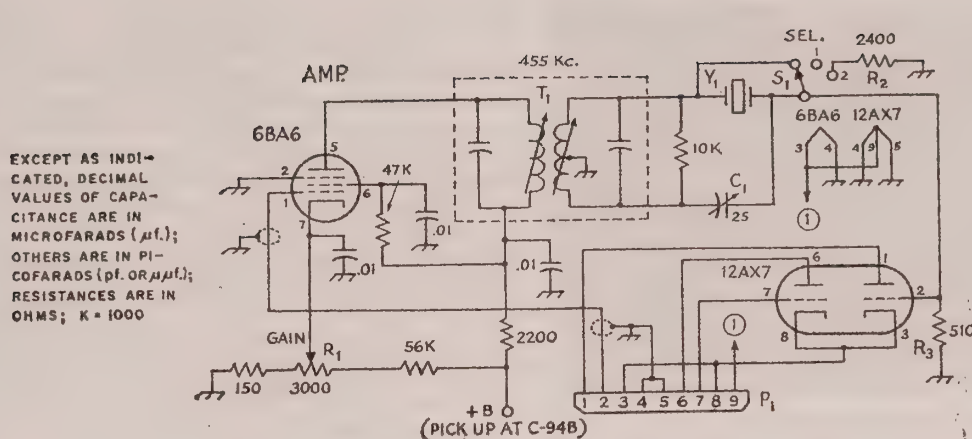


Fig. 2—Circuit of the crystal-filter adapter. Fixed capacitors are disk ceramic; resistors are ½ watt.

C_1—4.5–25-pf. ceramic trimmer (Centralab 822-AZ).
P_1—9-pin miniature plug (Amphenol 86-893).
R_1—Linear control.
S_1—Single-pole 3-position rotary switch (Mallory 3215J, 3 of 5 positions used).
T_1—455-kc. i.f. transformer, center-tapped secondary (Miller 912-C-3).
Y_1—455-kc. ± 50 c.p.s. series resonance crystal (Petersen Radio type Z-9).

The over-all result is a substantial improvement in the ability to separate c.w. signals. At W4BFR, the crystal selectivity switch is normally left in the NO. 1 position for general c.w. operations, and moved to the NO. 2 position only when conditions demand it.

The crystal-filter assembly is also useful when used with a 2.1- or 3.1-kc. mechanical filter instead of the 500-c.p.s. unit. The peak selectivity remains about the same, since the broad peak response of the mechanical filters does not contribute to the narrow-band selectivity. The skirt selectivity broadens out toward the limit set by the mechanical filter, but does not reach it since the crystal-filter skirt selectivity does make a contribution. The result is a useful increase in the c.w. selectivity over that obtained using a 2.1- or 3.1-kc. filter alone.

The Electrical Circuit

The schematic of the crystal-filter assembly is shown in Fig. 2. This is a version of the crystal-filter circuit that was, until recently, almost universally used in communications-type receivers. The basic design originated back in the 1930s. An extensive analysis of this type of filter is given in the *Radiotron Designer's Handbook*[1] for those interested.

P_1 plugs into the V-7 socket in the 75A-4 to pick up the pin connections and bring them up into the assembly. All pins except No. 2 go to the same numbered pins of a 9-pin socket in the assembly that takes the 12AX7 tube. Pin 2 on P_1 goes to the grid of the added 6BA6 i.f. tube. Gain control R_1 allows adjustment of the gain of this amplifier. The plate circuit of the 6BA6 feeds a 455-kc. i.f. transformer whose secondary is designed to feed push-pull diodes. Instead, it feeds the crystal and the neutralizing capacitor, C_1. This capacitor is adjusted to cancel signal feedthrough because of the crystal parallel capacitance. The only energy that passes is that through the crystal acting as a series-resonant circuit of high Q. The filter load resistors, R_2 and R_3, are in series with the series L, C, and R of the crystal and reduce the effective Q to control the selectivity. The higher the value of this load resistance, the wider the passband. The resistance values chosen give the selectivities shown in the table when switch S_1 is in the OFF, NO. 1 or NO. 2 position. In the OFF position, the crystal is shorted and selectivity is controlled completely by the mechanical filter.

It is necessary that the center frequency of the F455J-05 filter and the series-resonant frequency of the crystal match up closely to achieve a successful end result. A careful measurement of the center frequency of my 500-c.p.s. filter, using a BC-221 frequency meter, indicated that it was 455 kc. ± 50 c.p.s. Word from Collins Radio is that the F455J-05 filter production tolerances are 455 kc. ± 150 c.p.s. on the center frequency, and the bandwidth at the 6-db. points is 500 c.p.s. ± 25 per cent, or 375 to 625 c.p.s. In our case, the series-resonant peak of the crystal turned out to differ from the center of the passband of the mechanical filter by almost 150 c.p.s. Operation is quite satisfactory, although very little more difference could be tolerated without obtaining unsatisfactory performance.

Construction

All of the components and hardware are standard catalog items. The photographs show the layout of the components in the Bud Minibox (CU-3016A). If any variation from the arrangement is contemplated, it is important that the controls remain accessible when the assembly is installed in the receiver. Also, it is important that stray capacitance that may bypass signal energy around the crystal be kept to a minimum. The i.f. transformer trimmers, and gain control R_1 are accessible from above. The neutralizing

[1] 4th ed., Chapter 26. Edited by F. Langford-Smith; available from Tube Division; Radio Corporation of America, Harrison, N. J.

capacitor C_1 is reached from the rear through the hole in the side of the Minibox cover.

The selectivity switch, S_1, is mounted on an aluminum angle with the shaft projecting upward at a shallow angle. The shaft is coupled to a panel-bearing assembly through a universal-joint coupler (Millen 39005), and the bearing shaft projects through the slot in the end of the receiver case, and a suitable control knob is installed. The reason for the angular mounting of S_1 and use of the universal coupling will be explained later.

The mounting of P_1 so that it could plug into the receiver V-7 socket presented somewhat of a problem. The solution was found by mounting P_1 in the end of a 7-pin, 1¾-inch tube shield. The end of the shield is reamed out to accept P_1. The tube shield is shortened to 1½ inches, but cut so as to leave two ears that are bent outward 90 degrees and drilled. The shield then bolts to the end of the Minibox. To hold P_1 in place, another similar tube shield is used. The end is reamed out enough to clear the pins in P_1. It is then slotted down the side, and a strip about 1/16-inch wide is removed so that the shield can be compressed and slipped inside the outer shield with the reamed end pressing against P_1. The length of the inner shield must be cut so that when the assembly is bolted in place, the inner shield presses firmly against socket P_1. P_1 must be oriented properly to fit into the V-7 in the 75A-4 chassis. The reason that the shaft of switch S_1 comes out at a shallow upward angle is because the plug-in tube shield assembly turns out to be too short.

All power is obtained through the V-7 socket except B plus for the 6BA6 i.f. tube that was added. A lead comes out of the bottom of the filter assembly and is connected to C-94B under the 75A-4 chassis.

Adjustment and Use

Adjustment of the filter poses no particular problems. First, pick out a 100-kc. calibrator harmonic that gives an above-S9 reading on the S meter. Make a note of the actual reading. Next, install the filter assembly in the V-7 socket and install the control shaft for S_1 and make the B-plus connection. Carefully tune the receiver to find the crystal peak response. Adjust the slug trimmers on T_1 for maximum response. The primary trimmer peaks in a normally sharp manner. The secondary trimmer tunes very broadly, however, and the S meter must be watched closely to see the peak.

The adjustment of C_1 must be done with care. Turn off the calibrator, or tune away from it. With no antenna connected, advance audio and r.f. gain controls so that substantial noise is apparent in the headphones, but the receiver must not be overloading. This adjustment can best be done with the 2.1- or 3.1-kc. mechanical filter switched in. Turn the b.f.o. off. Now, with a nonmetallic trimmer tool, carefully turn C_1 while listening closely to the noise. Somewhere near mid-range the noise will change in character.

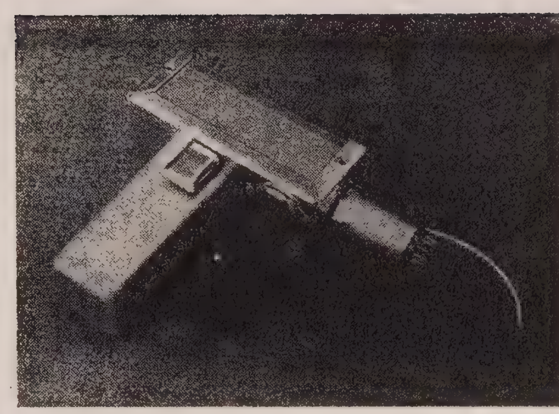


Fig. 3—This is the complete filter assembly ready to install in a Collins 75A-4. The quartz crystal is the small unit against the i.f. transformer. The top tube is the 12AX7, and the one to the rear is the 6BA6 that was added. The plug to go into the 75A-4 socket and the lead to pick up receiver B plus are also clearly shown.

It will decrease slightly in pitch and intensity. This is the point where C_1 neutralizes the capacitive coupling through the crystal, and gives the narrowest and most symmetrical passband. If, when tuning through a c.w. signal a rejection notch is found on either side of the peak response, a slight readjustment of C_1 needs to be made.

Now, with S_1 at OFF, set gain control R_1 to give the same S-meter reading on the calibrator signal as was recorded before the filter was installed. When S_1 is in the NO. 1 position, the gain should drop less than ½ S unit, and about 1 S unit in the NO. 2 position.

(Continued on page 166)

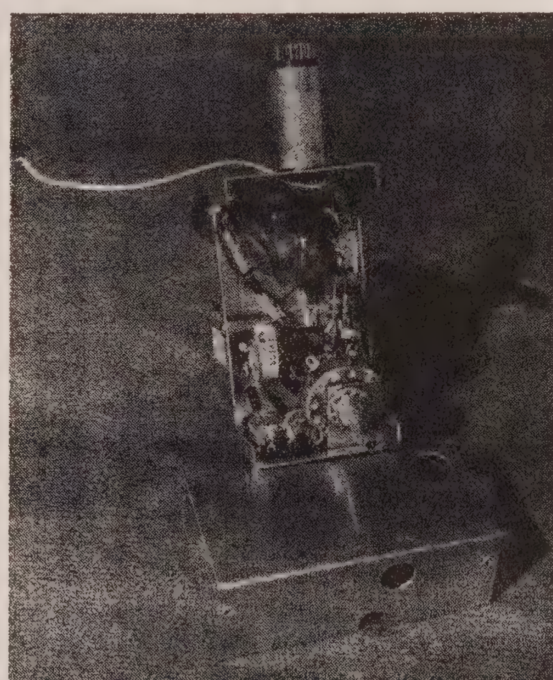


Fig. 4—Inside the Minibox are components and wiring. At lower right is selectivity switch S_1. At lower left is gain control R_1. The neutralizing capacitor, C_1, is to the left near the center.

food. Activities will include a transmitter hunt, a c.w. contest, a DX contest, election of a hamfest sweetheart, mobile judging, and entertainment for the children. For further info contact Otto H. Roehrs, Jr., K4EQK, 2350 Scaper St., Memphis — telephone GL8-9540.

Texas — The third annual meeting of the East Texas Emergency Net will be held at City Park, Commerce, Tex., Sunday, June 2. Registration $1. Talk-in 3970 kc. Picnic basket at noon, program begins at 2 P.M. Net Control Miss Helen Douglas, W5LGY. For further info contact L. E. Harrison, W5LR, 2410 Salerno Drive, Dallas 24, Tex.

Texas — The Permian Basin Amateur Radio Club will hold a Hamfest-Swapfest on June 2, at Ector County Coliseum Barn A, 42nd and Andrews Highway, Odessa, Tex. There will be talk-in on 3885 kc. The program includes movies for the children, bridge, canasta and dominoes for the ladies, dealer exhibits, RACES meeting, MARS meeting, an ARRL speaker, and a barbecue dinner. There will be plenty of tables and room for the swapfest, so bring all your swap gear. Registration is $1.25 in advance, or $1.50 at the door. For further info or pre-registration write PBARC, Box 1406, Odessa, Tex.

Virginia — The annual Roanoke Valley ARC will be held on May 25 and 26 at Vinton War Memorial, Vinton, Va. Open house Saturday, dance Saturday night. Playgrounds for children. Tennis courts. Sell and swap. Contests and prizes. Registration $2. Sunday meal $1.25, children 75¢. For further info contact Walter E. Wilson, Roanoke Valley ARC, Box 2002, Roanoke, Va.

Washington — The Amateur Radio Association of Bremerton will hold its annual hamfest and banquet (family style fried chicken) on Saturday, May 18, at the Sons of Norway Hall. Registration opens at 1300, dinner at 1900. During the afternoon there will be "bunny" hunts, a QCWA meeting, technical talks, c.w. contests, ragchews, etc. After the banquet, entertainment and dancing. Registration prior to May 10, $4.50 per person, $5.00 after that date and at the door. For reservations and further info, contact Harry W. Jackson, W7MCW, Route 5, Box 809, Bremerton, Washington.

Wisconsin — The annual Southeastern Wisconsin hamfest, sponsored by the Racine Megacycle Club, will be held at Dania Hall, 1019 State St., Racine, on May 25. Registration will begin at noon. Afternoon activities will include traffic nets and MARS meetings along with equipment displays. A roast beef/turkey dinner will be served at 1800. Entertainment will be followed by dancing. Ticket price is $3.75 per person. For additional information and registrations, write to Phil Neumiller, W9HAG, 1110 Summerset Drive, Racine, Wisconsin.

Maryland — A hamfest on June 2, 1963, at Marshall Hall, Maryland, sponsored by the Confederate States Rebel Net and the Confederate States Amateur Radio Club. In addition to the Rebel Hamfest there will be a dinner-dance at the American Legion Hall, Oxon Hill, Maryland, on 1 June 1963. The Rebel Queen will be selected at the dinner-dance. For further info contact Dave Danser, W4GVQ, 4900 Bristow Drive, Annandale, Virginia.

Improving the C.W. Selectivity of the Collins 75A-4

(Continued from page 57)

For those who do not have a 500-c.p.s. mechanical filter in their receivers and who like to experiment, improved selectivity can be achieved by misadjusting C_1 slightly to produce a rejection notch on one side of the crystal peak and then positioning the receiver's rejection tuning notch to the opposite side. This technique is not worth the trouble when a 500-c.p.s. mechanical filter is installed, however.

With S_1 off, the 75A-4 performs exactly as though the filter were not installed. T_1 produces no noticeable increase in selectivity, and the adjustment of R_1 assures no change in gain.

With S_1 in the NO. 1 or NO. 2 position, the

(Continue on page 168)

increased c.w. selectivity is there to be used and appreciated. Tuning must be done more carefully and the Collins 4-to-1 reduction tuning knob will be welcome if your receiver is fitted with it. You are now equipped with as good a c.w. receiver as is available in this day and age — and it works as well as it ever did on sideband! QST

Pulse — Part IV

(Continued from page 63)

in the large amount of surplus radar pulse equipment now available. The authors are by no means authorities on the surplus market, but some useful equipments are listed below:

APR-4, with tuning head TN-54 Radar receiver 2150 to 4000 Mc. Noise figure poor. L.o . in tuning head.

APR-5A Radar receiver, 1000 to 5000 Mc., in one assembly. Noise figure probably poor.

APR-9 with tuning head TN-128 Radar receiver, 1000 to 2600 Mc. Noise figure poor. L.o. in tuning head.

APG-5 or APG-15 Radar for B-29 tail gun, 2700 to 2900 Mc. Has pulsed 2C43 transmitter and 2C40 l.o., in cavities similar to those described in this series. Probably convertible to 2300 Mc. without too much difficulty.

2J39 Integral-magnet magnetron. 9-kw. peak power output, 3267 to 3333 Mc.

Response to previous articles of this series, and to demonstrations put on by the authors, indicates a considerable latent interest in microwave work. It is hoped that acquaintance with pulse will encourage more amateurs to try the space-age microwave bands, where there are many new opportunities for the operator or experimenter — newcomer or old-timer. QST

Bibliography

For those amateurs who wish to acquire a more basic understanding of microwave circuits and techniques, the following low-cost publications are available from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Generation and Transmission of Microwave Energy, Cat. No. D101.11:11–673. 204 pp., ill. Price, $1.00.

Microwave Techniques, Cat. No. D211.2:M58. 188 pp., ill. Price, 55 cents.

Microwaves and Waveguides, Cat. No. D211.2: M58/2. 56 pp., ill. Price, 25 cents.

Radar Electronic Fundamentals, Cat. No. N29.2: R11/3. 474 pp., ill. Price, $1.50.

Radar System Fundamentals, Cat. No. N29.2: R11/2. 394 pp., ill. Price, $1.25.

Radar Circuit Analysis, Cat. No. D301.7:52–8. 480 pp., ill. Price, $5.25.

Pulse Techniques, Cat. No. D101.11:11–672. 102 pp., ill. Price, 55 cents.

Most of these are training manuals used by the armed services. They are clearly written, with numerous illustrations.

Corrections

In Part III, Fig. 5, some dimensions of the antenna were omitted. The dipole element diameter is ¼ inch, as is the coax inner conductor. The outer conductor of the coax is ⅝-inch o.d. copper tubing, 1/32-inch wall. The end disk thickness is not important, other than that it be rigid. Brass or copper 1/16 inch thick is suitable.

A dimension was omitted in Fig. 6B of Part III. The length of the plate choke assembly is 1¼ inches.

7360 Mixers in the 75A-4

Reducing Overloading in Conversion Stages

BY JOHN H. DIEHL, W2QWS
52 Tacoma Ave., Buffalo, N. Y. 14216.

Although this modification is directed specifically toward the 75A-4, the same principles may be applied to the mixer stage or stages in other receivers.

SOMEONE has said that a receiver's performance should be judged not by what it can receive but by what it is able to reject. In quality amateur receivers, sensitivity has certainly been adequate for many years and the modern amateur receiver with a mechanical or crystal lattice filter offers selectivity that is limited only by the bandwidth of the intelligence to be received. A modern receiver would seem, therefore, to insure its owner many QRM-free QSOs unless the interfering signal is actually within the passband of the receiver.

Mixer Overload

Certainly this owner of a 75A-4 was quite happy on the top end of 20 for several years. While the population of the band increased, the same propagation conditions which have caused abandonment of the higher-frequency bands have also lengthened the skip distance so that the watts-per-kilocycle saturation has not been as great as one might expect. Dissatisfaction came with the increase in the local ham population, "barefoot" at first, and later well-shod with high-powered linears, trampling under foot the weak DX and making unusable large segments of the band. Tests with short antennas and attenuators at the input to the receiver revealed that while some signals were not free of excessive distortion products, and even parasitic oscillation on modulation peaks, the principal cause of the

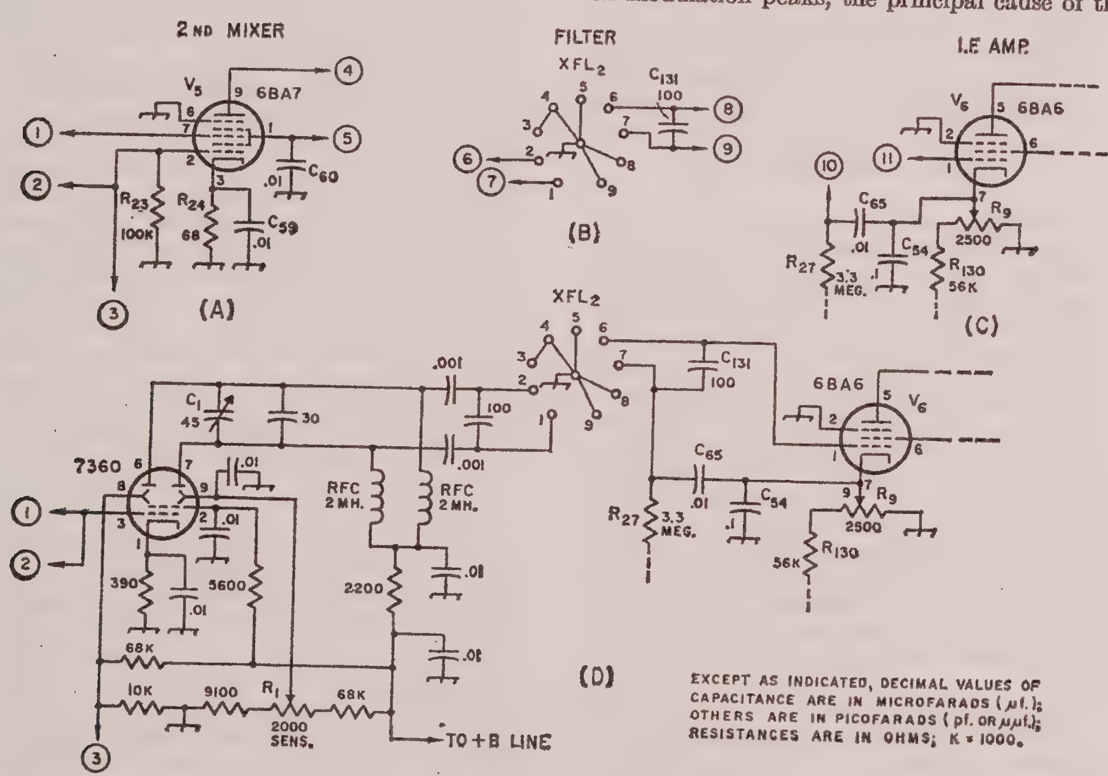
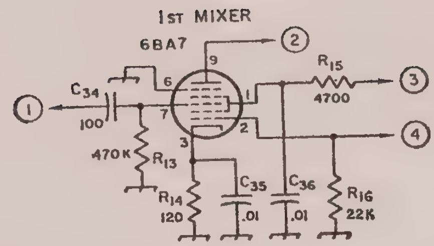


Fig. 1—Revisions in the second-mixer circuit. Original connections are shown for the second-mixer tube at A, to the 3.1-kc. mechanical filter at B, and to the first-i.f. amplifier tube at C. Circled numbers indicate points at which connections to the original circuitry should be broken. Components shown in A (only) should be removed or disconnected. D shows the revised second mixer circuit. Here the circled numbers indicate points where connections are made to similarly-numbered points in the original circuitry. Dashed lines indicate original connections which should not be disturbed. Heater connections remain unchanged. Fixed capacitors of decimal value are disk ceramic; others are mica or NPO ceramic. Fixed resistors are ½-watt composition. C_1 is a 7-45-pf. ceramic trimmer. R_1 is a linear control.

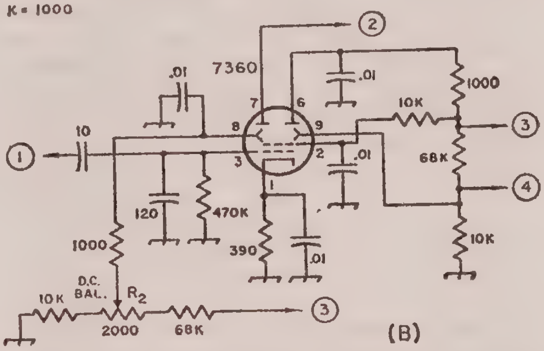
"broad" signals was generation of spurious products in the mixer stages of the receiver. Measurements with a signal generator indicated that the fellow in the next block could not possibly overload the r.f. stage and that we could always resort to the now well-known 20-db. pad in an emergency.

Concentration was focused on the mixer circuits, and past articles in *QST* were reviewed and several promising circuits were tried.[1] At about this time, the Squires article on the use of the 7360 switch-beam tube appeared.[2] Study of the 75A-4 schematic and component location indicated that some version of the Squirescircuit could be incorporated with a minimum of work and that the circuits could be restored to their original form in the event that results were not satisfactory. Preselection in the 75A-4 before both mixer tubes is sufficient to reject unwanted signals separated from the oscillator frequencies by the i.f., and also to prevent any intrusion of a signal on either of the intermediate frequencies. In the interest of simplicity, some of the advantages of the balanced-mixer circuit can therefore be sacrificed while retaining the strong signal-handling ability and low mixer noise of the 7360.



EXCEPT AS INDICATED, DECIMAL VALUES OF CAPACITANCE ARE IN MICROFARADS (μf.); OTHERS ARE IN PICOFARADS (pf. OR μμf.); RESISTANCES ARE IN OHMS; K = 1000

(A)



(B)

Fig. 2—Revisions in the first-mixer circuit. A shows connections to the original 6BA7. Circled numbers indicate points at which connections to the original circuitry should be broken. All components shown should be removed or disconnected. B shows the revised first-mixer circuits. Here the circled numbers indicate points where connections are made to similarly numbered points in the original circuitry indicated in A. Heater connections remain unchanged. Capacitors of decimal value are disk ceramic; others are mica or NPO ceramic. Fixed resistors are ½-watt composition. R_1 is a linear control.

New Circuitry

Comparison of the revised circuits of Figs. 1B and 2D with the original in the 75A-4 manual illustrates the circuit changes. The second mixer has a balanced output, but oscillator injection is to one deflection plate only, with the other at r.f. ground potential. The first mixer (Fig. 2B) is simply a tetrode amplifier with the output switched to ground at the rate of the first-oscillator frequency. Input to the first mixer is tapped down on the r.f. amplifier output by a 12-to-1 capacitive voltage divider. The quiet 7360 mixer permits this reduction in its signal input, thereby affording a 12-to-1 increase in strong-signal protection while maintaining the signal-to-noise ratio. Noise from the r.f. amplifier (50-ohm resistor across the antenna terminals) overrides the mixer noise by a comfortable margin, and the increased gain of the 7360s over the 6BA7s leaves the over-all gain of the 75A-4 unchanged.

Second Mixer

Rework of the 75A-4 is best done one mixer stage at a time, with realignment and evaluation of results before proceeding further. Referring to Fig. 1, changes in the second mixer circuit are quite straightforward. The tube socket must, of course, be rewired. Two terminal strips are added. One of these is fastened to the shield between the mixer stages to mount the resistors for the deflection plates, and the other is mounted on the chassis between the tube socket and the mechanical-filter sockets to hold the 2-mh. chokes and the 45-pf. trimmer capacitor C_1. The additional 2-mh. choke was stolen from the Q-multiplier plate circuit (L_{25}) and the latter replaced with a standard 2.5-mh. choke. The 2000-ohm potentiometer R_1 is conveniently mounted in an existing hole in the shield. Note that the arrangement used by the author renders the selectivity switch inoperative, only the 3.1-kc. filter being used. Rebuilding of the switch has been postponed to a later date. When the wiring is complete, the 45-pf. trimmer C_1 is peaked for maximum signal and the 1.5- to 2.5-Mc. variable i.f. tuning is realigned following instructions in the receiver manual. The potentiometer R_1 is set for maximum output on a weak signal. Gain will be found to have been improved by at least 10 db., and it may be necessary to reset R_9, the i.f. gain control, to prevent a.g.c. action on tube noise.

Those who do not have a signal generator will find that the markers from the 100-kc. calibrating oscillator can be used for peaking the tuned circuits. With the band switch set to the 10-meter band, peak L_{18} and L_{22} at 28.9 Mc. and C_{53} and C_{56} at 28.1 Mc. Either the S meter or a v.t.v.m. at the diode load test point (a.g.c. off) may be used as an indicator. A record of the S-meter readings of the 100-kc. oscillator signal on each band can serve as an indicator of receiver per-

[1] Andrade, "Recent Trends in Receiver Front-End Design," *QST*, June, 1962, and many others.

[2] Squires, "New Approach to Receiver Front-End Design," *QST*, September, 1963.

formance before and after changes. Such a record is also useful as a long-term check on receiver sensitivity. This is often reassuring when the band seems dead!

First Mixer

Referring to Fig. 2, revision of the first-mixer circuit requires a 180-degree rotation and rewiring of the tube socket. Coupling capacitor C_{34} is replaced by a 10-pf. mica unit, and a 120-pf. capacitor is shunted from grid to ground. These values are a compromise between gain and overload protection, either of which can be improved at the expense of the other. The new circuit changes the load on the crystal oscillator, and it will be necessary to carefully peak the oscillator coils L_{11} through L_{17} to restore the 100-kc. calibration signals to zero on the dial. Setting of the 2000-ohm potentiometer R_2 is not critical and it may not be needed with most tubes. It is only necessary that d.c. voltages on the deflection plates be approximately equal. Trimmer C_{53} is now peaked as before and the antenna and r.f stage realigned. This procedure is fully described in Section V of the instruction book.

Results

Using a Measurements 65B signal generator (with 50 ohms in series), sensitivity was found to be 0.8 μv. at 10-db. signal-to-noise with 30 per cent modulation at 28.5 Mc. This is a.m. sensitivity. S.s.b. sensitivity measured better by 12 db.[3] Gain distribution was also measured. For output at the detector load equivalent to that produced by 1 μv. at the antenna terminals, the following readings were made. r.f. grid — 7 μv., first-mixer grid — 13 μv., second-mixer grid — 70 μv., and first-i.f. grid — 170 μv. Gain from antenna to second-mixer grid is therefore 70 times. Since the negative bias on the second mixer is 2.5 volts, any signal greater than 35,000 μv. peak at the antenna will drive the mixer grid positive if not controlled by the a.g.c. or rejected by the front-end selectivity. The 7360 displays good linearity up to the point of overload. In actual use, signals below 10 v. are R4 to 5 at a separation of 20 to 40 kc. from a signal which drives the S meter to full scale (approximately 50,000 μv.). A high-level s.s.b. signal such as this from a well-designed transmitter may contain higher-order distortion products of 25 μv. or more at 25 kc. removed from the signal frequency.[4] So we see that there exist certain practical limits to receiver performance at this present state of the art of amateur-transmitter design.

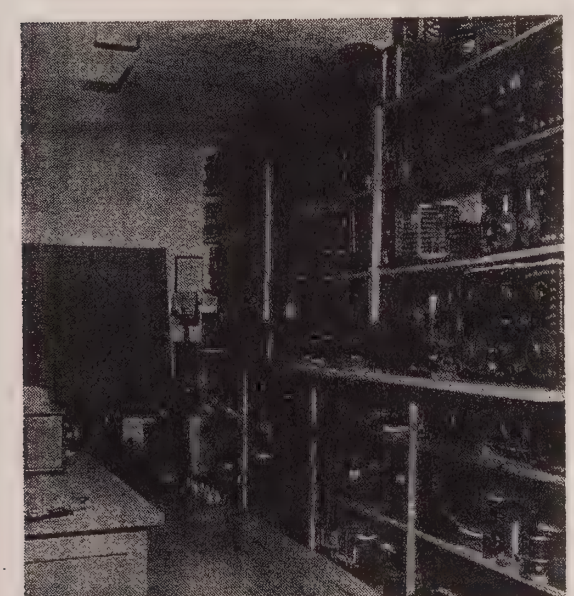
The modified A-4 has now been in use for several months. The receiver front end no longer wilts in the presence of several local signals, and it is possible to copy s.s.b. DX on the low end of 20 when the c.w. station across the back yard is pounding away. The 20-db. pad with toggle switch is still in series with the receiver input, but is seldom used except to check incoming signals for splatter or key clicks. For this purpose it is used frequently! QST

[3] Pappenfus, Bruene and Schoenike, *Single-Sideband Principles and Circuits*, McGraw-Hill, 1964, p. 341.

[4] Ibid., pp. 185–186; p. 358.

Strays

WB2GMN would like to contact past members of the Second Signal Service Battalion stationed at Radio Marina, Asmara, Eritrea, during WW II.



Feedback

There are two errors in the circuit diagram of the audio section of the TDCS transistor communications receiver appearing on page 17 of the November, 1963 issue. In the squelch circuit, there should be no connection between R_6 and the 1N1619; the 10K resistor should be connected between the bottom end of R_6 and ground, rather than as shown.

The headphone jack, J_6, should be connected as follows: the movable arm should go to S_{3B}, the stationary contact should go to the 8-μf. capacitor, and the frame of the jack should be grounded.

In the McCoy article, June 1964 *QST*, page 40, the two sections of L_3 in Fig. 2 should be 32 turns each, not 28.

This is just part of the famed W2ZI Historical Museum in Trenton, New Jersey. Maybe you OTs ("young squirts" are welcome, too) will want to make it a part of your summer trip to ARRL. It's open to the public "almost anytime," by appointment. On display are more than 400 items dating from the wireless days of 1899–1925; a collection of Morse and wireless keys, old vacuum tubes of significant types, and papers, photographs, and magazines dating 'way, 'way back. If you plan to visit the museum, telephone or write W2ZI a few days in advance so arrangements may be made. On arrival in Trenton, phone 822-6645 for further directions if needed.

Improving THE 75A-4 ON SSB

BY KELTON C. AGRELIUS,* K6SHA

The sterling qualities of the Collins 75A-4 need no review. However, this fine receiver did appear before sideband techniques were perfected. The modifications described below will improve sideband performance and the signal to noise ratio.

THIS article covers a few modifications which when installed in the 75A-4 receiver will improve its operation considerably. The aggravating pumping action on s.s.b. with the R.F. GAIN control full on is completely eliminated. Also, the background noise while tuning for a signal is reduced while the signal to noise ratio is improved. The modifications are relatively simple and require only a few parts for installation.

First Mixer

Figure 1 shows replacement of the first mixer, V_3 with a 12AT7 type tube. This circuit taken from an issue of *CQ*[1], was modified slightly from the original by the addition of a 100 mmf capacitor across the cathode resistor. This was necessary to compensate for loss of gain in the circuit at the lower frequency bands. No major realignment is required. A slight readjustment of L_{11} through L_{17} is necessary to insure that the crystal oscillator tube, V_4, is operating properly, especially on the higher frequencies. A noticeable reduction in noise level of the receiver will be observed because the 12AT7 as a triode mixer has less gain than the 6BA7. Signal to noise ratio checks made against an unmodified 75A-4 receiver as a comparison showed approximately one db improvement in the modified receiver.

Second Mixer

Figure 2 illustrates the replacement of the second mixer, V_5, with a 6U8A tube. Also taken from a previous *CQ* article,[2] this change, in addition to the others to be described, completely eliminates pumping or thump with the R.F. GAIN control full on. This is a great advantage when listening to strong signals and a weak signal tries to break in. Without the modification, when the R.F. GAIN is reduced to eliminate pumping, the weak signal is lost due to the reduced sensitivity.

In performing the modification of both mixers it is not necessary to reorient either tube socket. Rewiring some of the original components and installing additional components is not difficult and lead length is not too critical.

*2109 Saxe Court, Thousand Oaks, California.

[1]Sideband Column, *CQ*, November 1962, page 77.

[2]Sideband Column, *CQ*, July 1960, page 81.

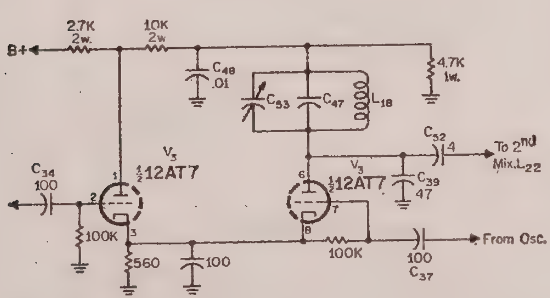


Fig. 1—Modified circuit of the first mixer of the 75A-4 shows a 12AT7 replacing the 6BA7. All components with numbers are original Collins parts. Those unmarked are added components. All new capacitors are in mmf.

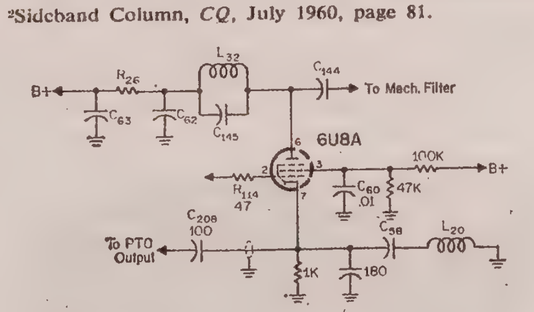


Fig. 2—Modification of the second mixer of the 75A-4 is shown above. A 6U8A replaces the 6BA7, V_5.

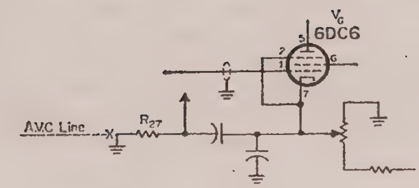


Fig. 3—Modified circuit of the first i.f. amplifier, V_6, of the Collins 75A-4 receiver. The a.v.c. line is broken at point X and R_{27} is grounded as shown. The original 6BA6 is replaced with a 6DC6 as described in the text.

I.F. and A.V.C. Modifications

Further modifications to eliminate the pumping action consists of replacing the first i.f. amplifier, a 6BA6, with a 6DC6 and the removal of a.v.c. from the first and third i.f. stages.

As shown in fig. 3, the first i.f. amplifier tube, V_6, is changed from a 6BA6 to a 6DC6 and the a.v.c. is removed from the grid circuit of the tube. The connection on pin 2 on the tube socket is removed from ground and connected to pin 7. The a.v.c. is removed by disconnecting the a.v.c. line from R_{27} and grounding R_{27}.

The sensitivity of the "S" meter is changed slightly by this modification, and must be re-adjusted. This can be done easily by use of the Crystal Calibrator as a reference. Before the modification, note the reading of the "S" meter on one of the lower bands with the Calibrator

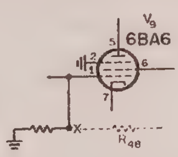


Fig. 4—The circuit of V_9, the third i.f. amplifier is modified only to the extent of removing a.v.c. voltage from the grid by disconnecting R_{48} at the point marked X.

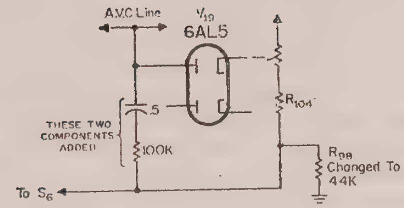


Fig. 5—The a.v.c. time constants are changed by the circuit variations shown above. The series 0.5 mf and 100K are added and R_{98} is changed from 27K to 44K. For even faster recovery, replace the 0.5 mf with a .25 mf.

on and after the modification reset the sensitivity control so the meter reads the same level.

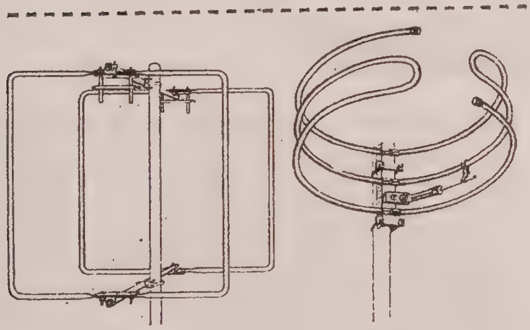
In fig. 4, the a.v.c. is removed from the third i.f. amplifier tube, V_9, by breaking the circuit between R_{48} and R_{70}. Grid return for V_9 is provided by R_{70}.

A.V.C. Time Constants

In fig. 5, a 0.5 mf capacitor and 100K resistor in series are connected from the a.v.c. line to the junction of R_{104} and R_{98}. This provides a slightly longer hang time especially in the SLOW AVC position. If not connected in this manner the recovery time of the circuit would not be fast enough for normal operation in the SLOW AVC position when the receiver is switched to the OPERATE position from STANDBY. Resistor R_{98} is changed to a 44K because a higher negative bias is required in the STANDBY position due to the removal of the a.v.c. from V_6 and V_9. The a.v.c. line previously provided negative bias to these two tubes in the STANDBY position.

The above modifications have been installed and used in the writers 75A-4 receiver for over a year and it is his belief that, with the modifications installed as shown above, the 75A-4 is hard to beat as a top-notch s.s.b. receiver. ■

New Amateur Products

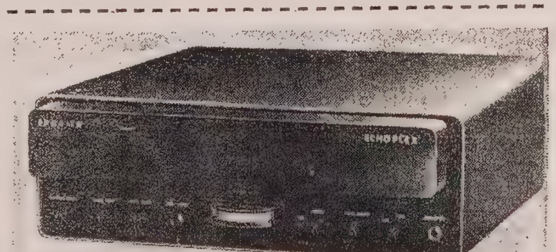


Hi-Par Antenna

Two new antennas were introduced by Hi-Par. The "Tu-Quad (left) is a collapsible quad for 2 meters. It sells for $11.95. The coronet (right) is a halo type antenna. Electrically it is three half wave lengths long with two sections in phase for gain, and the third out of phase for feeding. The net price is $8.95. For further information write to Hi-Par Products, 347 Lunenburg Street, Fitchburg, Mass., or circle 64 on page 110.

Kahn Echoplex System

The patented Echoplex system is an audio processing device which encodes the speech wave by separating it into six frequency segments with six bandpass audio filters. For complete details write to Kahn Research Laboratories, 81 S, Bergen Place, Freeport, L.I., N.Y. or circle 65 on page 110.



bination is to build in a 500-cycle filter i.f. stage, then precede this with a stage having options for narrower selectivities. For example, insert a 500-c.p.s. mechanical filter between 1st and 2nd i.f. stages and a 200-c.p.s. filter between the mixer and 1st i.f. stage. Thus the limitations of interstage shielding are improved from, say, 50 db. to 100 db. with respect to skirt rejection.

Receiver Dynamic Range

The exploitation of i.f. and a.f. selectivity advantages (as opposed to pre-receiver r.f. selectivity) is seriously inhibited by dynamic-range limitations in all present-day receiver designs. There is no use building in 100-db. rejection to outband signals, if, as is often the case, a few of them can get together and drop cross-products only 40 db. down squarely in the passband. Present-day station-design provisions are (a) pre-selectivity (b) pregain gain-control, usually by simply switching the preamplifier in/out, and (c) use of 7360 or equivalent mixers. Naturally, one uses as little r.f. gain as possible during interference conditions, and the receiver must have a separete r.f. gain control for this adjustment.

The 75A4 Receiver

Some DXers of proven good judgment hold that the 75A4, suitably modified, is the best receiver ever made. The simplest modifications are:

(1) Remove i.f. shunt resistors R46 and R29
(2) Remove a.f. feedback resistors R71 and R109. Substitute 820K for R109.

More complicated steps are:

(3) Install 7360 mixers per *QST*, July, 1964, p. 18.
(4) Install 6GM6 or 6EH7 stage with appropriate cathode and a.g.c. arrangements.

Reported results are: 12-db. improvement in sensitivity, better dynamic range (less nearby-signal overload problem), and less hum.

Some experienced 75A4 modifiers (W2JT, K3OKX and W2VCZ) prefer a 12AT7 first mixer (presumably per *73* Magazine. Oct. 1961, p. 32) and 6EA8 second mixer (presumably per *CQ*, June, 1960, p. 81, which is for the earlier 6U8A). The 7360 modification is complicated.

Serial numbers of 4200 and over are prized by 75A4 connoisseurs. These are the latest production version, and include the very-worthwhile vernier tuning knob. They may be recognized instantly by the lettering, upper right-hand corner of the front panel, NOISE LIMITER and AM CW-SSB all being on the same horizontal line.

A difficulty that occasionally occurs with aging 75A4s is p.t.o. instability. It is characterized by a lurch of one to five kc. This is especially noticeable because, when good, the receivers are paragons of frequency stability. Some steps to correct PTOs:

(1) New 6BA6s, V-14 & V-15; 0A2, V-18; and 5Y3, V-17.
(2) Replace C205, 51 pf. This can be done without removing p.t.o.
(3) Loosen p.t.o. mounting screws. Manually wiggle to relieve stresses. Retighten softly.
(4) Lubricate p.t.o. front bearing.
(5) Wring out 8 holes, 1 inch diameter, on the bottom cover plate under p.t.o. to ventilate. Replace 5Y3 with silicon plug-in.
(6) Replace the padder, and (especially) the temperature compensators.

If it reaches the point of Step (6), it's worth their fee (currently $46.00) to send the 70E24 back to Collins Cedar Rapids for turn-around. They have a temperature-cycling and calibration jig. QST

(Part IV of this series will appear in an early issue.)

Strays

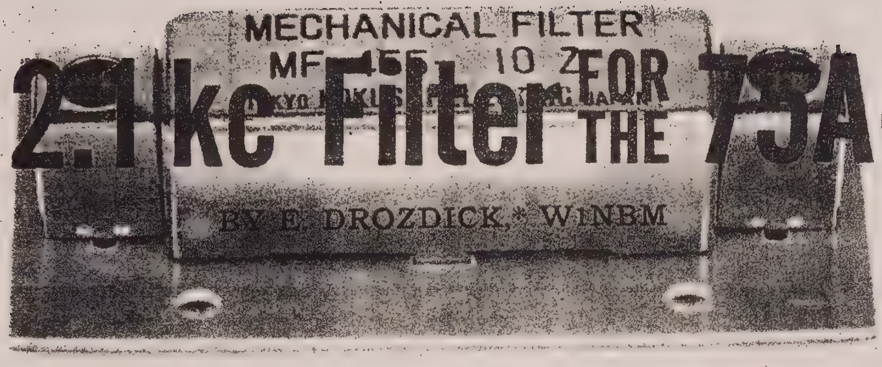
WWV TO QSL "FIRST-DAY" RECEPTION

Want a gold-bordered QSL card showing the new WWV at Fort Collins, Colorado? Then be on deck when the changeover from the old station to the new takes place at 0000 GMT on December 1, 1966. Send your own QSL card to David H. Andrews, Chief, Frequency-Time Broadcast Services Section, Radio Standards Physics Division, National Bureau of Standards, Boulder, Colorado 80302, reporting the time of reception and quoting the new WWV voice announcement. To qualify for the WWV "First Day" card you must quote the announcement correctly and your card must be postmarked before midnight December 2, 1966, local time. WWV's QSL will have stamped on it the date and time of your reception of the signals. The three amateurs showing earliest reception time will receive, in addition, a framed 11 by 14-inch color photograph of the scene appearing on the QSL card.

Feedback

In the article, "The Simple Super-9," by W4GEB on page 22 of August 1966 *QST*, 13th line from the bottom of the first column, the term R_1 should read L_1.

Hotshot c.w. operators won't need to be told that we goofed in our space lengths in the tabulation on page 12 of the October issue. According to page 17 of *Learning the Radiotelegraph Code*, the additional space between letters is *two* code elements and the additional space between words is *six* code elements.



A 2.1 kc Filter FOR THE 75A-4

BY E. DROZDICK,* W1NBM

How to modify the inexpensive 2.1 kc filter for use in the Collins 75A-4.

THE 75A-4 receiver has provisions for a 2.1 kc filter but for those who lack this filter a moderately priced 2.1 kc unit is marketed by Lafayette. It is an imported unit, (catalog 673, page 14, part number 99F0123) priced at $9.95.[1] Unlike the Collins filter the Lafayette unit must be modified slightly and a simple mounting bracket fabricated.

Filter Modification

A drawing of the top and bottom views of the filter are shown in fig. 1. The modifications shown in the bottom view are: 1) the drilling of two holes through the fibre large enough to clear 4-40 screws; 2) removal of the etch from the printed board around the ground pin on the grid side (shown by the cross-hatched area).

Mounting Bracket

The mounting bar is fabricated from a 1⅜″ length of ¼″ × ¼″ brass rod drilled and tapped as shown in fig. 2. The two 4-40 holes are used to secure the filter to the brass rod. The ⅛″ hole is used to pass one of the connecting wires through the block and the hole for the wing nut is used to secure the assembly to the mounting bracket in the 75A-4.

*30 Nebo Street, Medfield, Mass. 02052.

[1] This filter was reviewed by *CQ* in March, 1965, page 43.

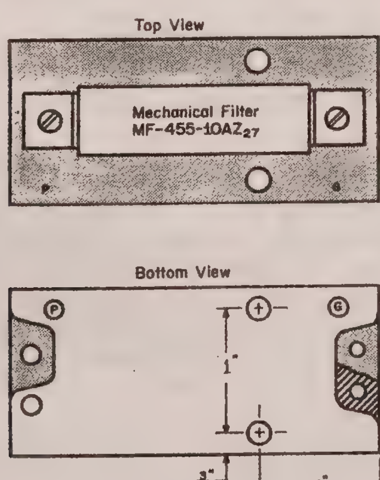


Fig. 1—Top and bottom views of the Lafayette 2.1 kc (455 kc) mechanical filter modified for use in the 75A-4. The input and output transformers are at each end of the filter.

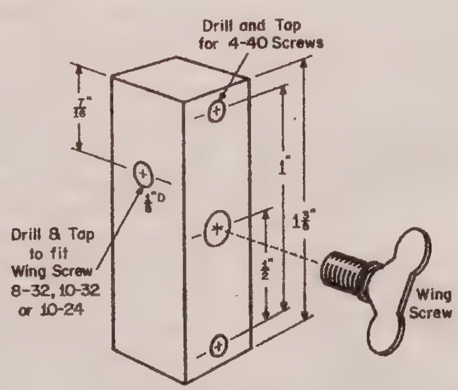
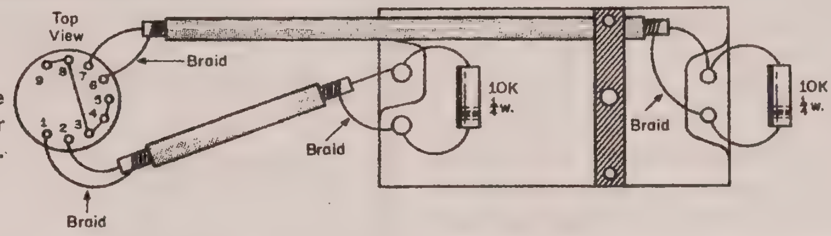


Fig. 2—Details of the ¼″ × ¼″ × 1⅜″ brass rod needed to mount the Lafayette 2.1 kc filter in the 75A-4.

Fig. 3—Wiring for the Lafayette 2.1 kc filter for use in the 75A-4.



Wiring

Cut two lengths of plastic covered shielded wire or coaxial cable about 1/10" in diameter, one 4" long and the other 2" long and dress the lead ends as shown in fig. 3. Shunt the filter terminals with 10K, ¼ watt resistors and connect the shielded wires. The 4" length of shielded wire connects to the grid terminal with the braid connecting to the pin from which the etch was removed. This braid should not be grounded.

The 2" length connects to the remaining two terminals with the braid connection made as shown in fig. 3. The connections are made to a 9 pin male plug to fit the filter socket.

Adjustment

Connect the filter in the 2.1 kc filter socket but do not mount it against the bracket yet. Turn the receiver on and tune to 3.4 kc with the calibrator on.

Place the selectivity switch on 3.1 kc or the 6.0 kc position (but not 2.1 kc) and peak the tuning for maximum S-meter reading and note the reading carefully.

Switch to the 2.1 kc filter and adjust the input and output transformers located on the new mechanical filter until the S meter reading is the same as it was in the 3.1 kc or 6 kc filter position. Also check to be sure the bandpass is as flat as possible. Now mount the filter with the wing bolt.

The shape factor of the Lafayette filter was checked against that of a Collins 2.1 kc unit and was found to be almost identical. ■

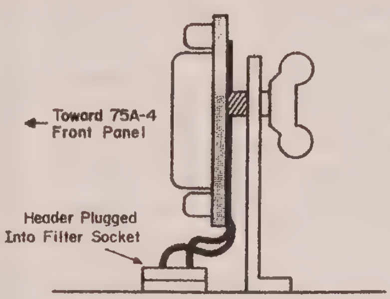
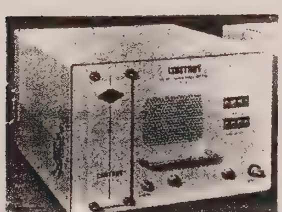


Fig. 4—Filter mounting and connection.

New Amateur Products

Gonset



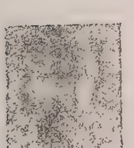
A NEW mobile v.h.f. linear with built in solid state supply has been announced by Gonset. The "Comtron" mobile linear covers the entire two meter band and may be driven to 180 watts p.e.p. by an exciter in 5 to 30 watt range. It is priced at $299.00. For full specs write to Don Ward, Sales Manager, Gonset, Inc., 1515 S. Manchester Ave., Anaheim, California, 92803, or circle 65 on page 126.

Stanley

STANLEY introduces a new driver that accommodates 15 standard sizes of hex nuts and screws. For further information write to: Dept. PID, The Stanley Works, New Britain, Conn., 06050 or circle 66 on page 126.

improving overload response in the Collins 75A-4 receiver

Simple modifications provide 13 dB higher signal-handling capability in this fine receiver



Raymond F. Rinaudo, W6ZO

Having obtained only limited results trying to improve the performance of commercially designed electronic equipment, I came to the conclusion that the designers knew what they were doing all along. Even so, the temptation to modify equipment is hard to resist, and my latest modification attempt resulted in a 13-dB improvement in strong-signal-handling capability of the 75A-4 receiver. However, this was achieved by second-guessing Collins engineers some fifteen years after the set had been marketed!

A recent book on ssb techniques indicates that a substantial improvement in receiver overload response can be obtained by reworking the mixer circuits.[1] Those interested in the subject are urged to obtain a copy of this work.

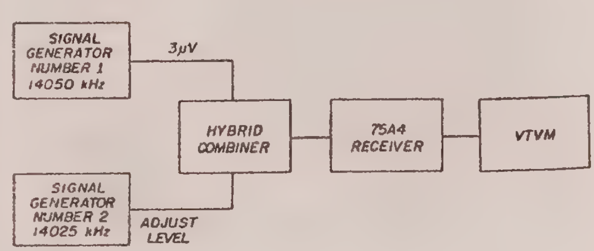
I decided to modify my 75A-4 because several nearby stations caused front-end overload. This causes a decrease in weak-signal strength, even though the interfering signals are 25 to 50 kHz away. It's all but impossible to copy a weak cw signal under these conditions.

The remedy is easy: about five dollars worth of parts and a little time. Here's how to do it.

primary work

First replace marginal tubes, then align the receiver. Overload response may be checked using the setup in fig. 1. Set signal generator 1, representing the desired signal, to 3 microvolts at 14,050 MHz. Turn the receiver avc off and the bfo on. Now increase generator 2's level (at 14.025 MHz) until the desired signal, measured by the vtvm, decreases by 3 dB. This will require about 13,000 microvolts. All subsequent measurements are referenced to this level.

fig. 1. Test circuit for measuring effectiveness of receiver modifications.



first mixer modifications

Replace the 6BA7 first mixer with a 12AT7. The modifications, fig. 2B, require only one 470-ohm ½-watt resistor and the 12AT7. Remove R14, R15; C35, C36. Revise the heater circuit as shown.

Next replace the 100-pF coupling capacitor with a 15-pF silver mica, then connect another 15-pF silver mica between grid and ground. This forms a capacitive voltage divider that reduces signal level to the first mixer grid. (The photos show a modified and unmodified set; actually, these are photos of two different receivers.)

After these changes have been made, peak the mixer grid and crystal-oscillator circuits for each band; also peak the mixer plate circuit. Only the capacitors should be peaked: C23, C26, C28, C30, C31, C32 and C17 in the mixer grid and C53 in the plate circuit.

The high-frequency crystal oscillator tuned circuits must also be retuned. Peak the tuning slugs on L11 through L17. Until the oscillator has been peaked, you'll probably find that the 21-MHz and higher-band crystals won't oscillate.

After the first mixer has been modified, a 24,000 microvolt signal will be required to cause a 3-dB decrease in the desired signal. I made this test before the two 15-pF capacitors were installed.

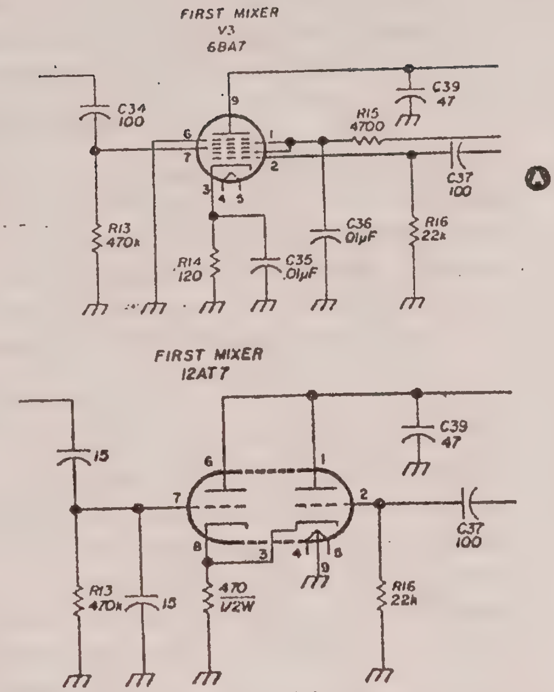
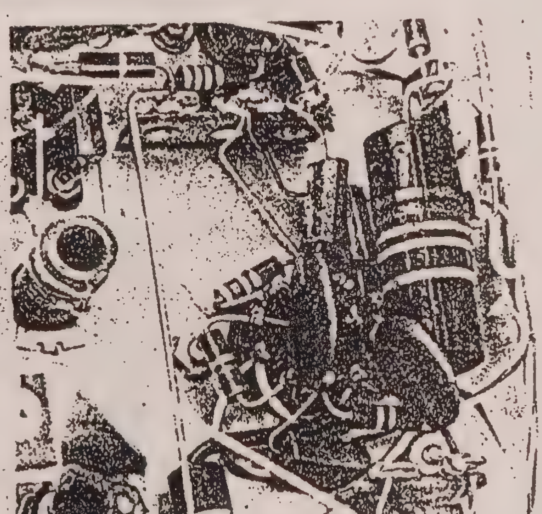


fig. 2. The 75A-4 first mixer before modification, A, and after, B. New parts consist of the 12AT7 and the 470K resistor.

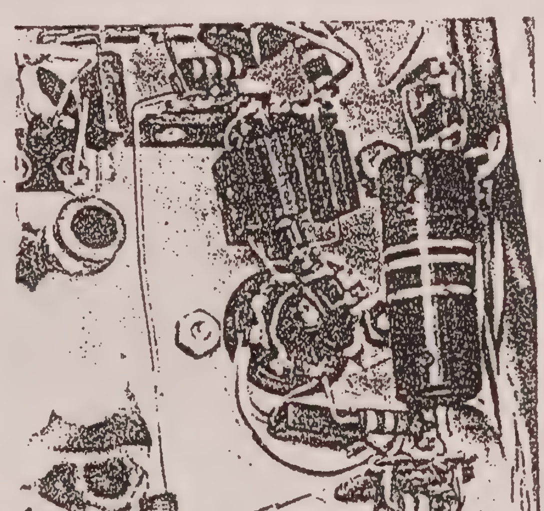
second mixer modifications

The next step is to replace the 6BA7 with a 6DJ8. Before and after circuits are shown in fig. 3. The new tube plus four new parts are required: a 1k, 1.2k and 3.3k ½-watt resistor and an 820 pF silver mica capacitor. If you can't find an 820 pF capacitor, anything between 680 and

Wiring of unmodified 75A4 first mixer.



Modified first mixer; note reduced number of parts.



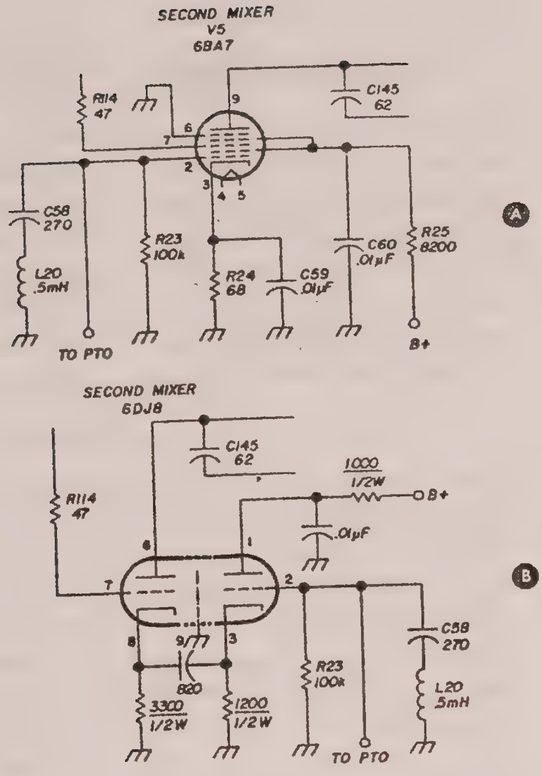


fig. 3. The 75A-4 second mixer. Original circuit is shown in A; modifications in B. Only five new parts are required for the change.

1000 pF will do. Remove R24, R25 and C59. Heater wiring is unchanged in this circuit. Complete the revision shown in fig. 3B. Peak the grid input circuits by tuning C56. Do not change inductor tuning.

After making the changes to the second mixer, check receiver performance again. A 40,000 microvolt signal from generator 2 will be required to reduce the desired signal by 3 dB.

final checks

In my receiver, the capacitive voltage divider was installed after modifications to the second mixer. A final check showed that an undesired signal of 60,000 microvolts was required to reduce the desired signal by 3 dB (voltage ratio of 4.5).

conclusions

Measurements at 28 MHz showed an improvement of 3 dB in signal-plus-noise ratio. Over-all receivers gain was somewhat lower, but this was more than compensated by the receiver's response to weak signals in the presence of local signals. More than enough gain was still available, however.

A type 6922 tube can be used instead of the 6DJ8. The 6922 has the same characteristics as the 6DJ8 but costs about three dollars more.

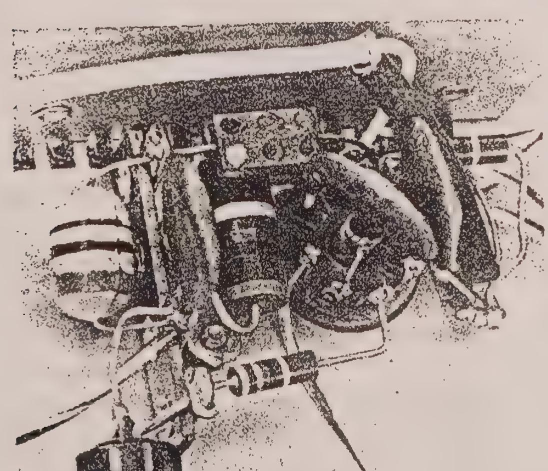
The modifications described are easily applied to the Collins 75A-4 receiver. The improvement in performance is well worth the investment in time and money.

references

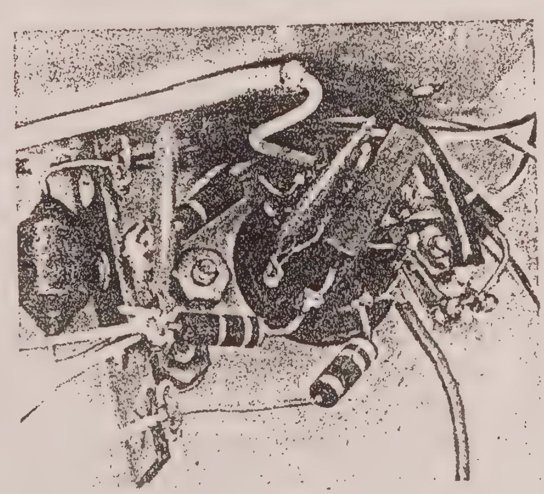
[1] Pappenfus, Breune, and Schoenike, "Single Sideband Principles and Circuits," McGraw-Hill, Inc., New York.

ham radio

Unmodified 75A4 second mixer.



Component layout of modified second mixer.



75A-4 modifications

To anyone who has owned and cherished a 75A-4 receiver for many years, as I have, the discovery that it has developed sensitivity and frequency-stability problems is like discovering a trusted friend to be unfaithful. Here are some solutions to these problems, plus a hint to improve the receiver's audio response.

insensitivity

Loss in sensitivity first appeared as a loss of one or two S-units after about an hour of operation. (I use the "calibrate" signal as a sensitivity reference for a specific S-meter reading at 14.2 MHz, with a 50-ohm dummy antenna.) Sensitivity loss gradually increased until it was 6 or 7 S-units after 15 minutes of operation.

After several frustrating weeks of signal tracing and a new set of tubes, I was about to give up when I stumbled onto the answer. The "rejection tuning," which is a bridged-T filter, has a sharp, deep null when properly adjusted. I noticed that when the set was first turned on, the "rejection tuning" behaved normally, but after warmup the null deteriorated and finally became useless. It seemed as though a comparitively low resistance was across the bridged-T inductor, L26.

The schematic shows one-half of V7, the Q-multiplier tube; some resistors; a choke; and C71, a 1000-pF capacitor in series across this inductor. Checking with a vtvm between ground and either side of L26 showed a *positive* voltage, which varied between 2 and 5 volts. I disconnected C71 from the inductor, but left the other end connected to the plate of V7 (and hence, B+). When I touched the vtvm probe to the free end of C71, I found the positive voltage to be even higher and still varying.

I checked other grids in the receiver with the vtvm and found four other leaky capacitors. When these were replaced, the sensitivity problem cleared up completely. A vtvm must be used, however. A 20k-ohms-per-volt vtvm simply shorts the leaky voltage to ground and gives no indication.

probable cause

When checking for leaky capacitors the set must, of course, be on and the rf gain control positioned fully clockwise. If the rf gain control is backed off, the higher bias voltage will swamp the leakage voltage on some of the grids. I can only conjecture as to the cause of the capacitor leakage; but my friend Ray Wood, W9SDY, suggests migration of the silver coating on the mica. Until a better explanation comes along, I'll accept Ray's theory. Migration is supposed to accelerate in the presence of a dc voltage. However, some unused mica capacitors of the same type and vintage showed leakage to some degree; new units showed no leakage at all.

frequency instability

The frequency instability problem became evident in exactly the opposite manner. The pto frequency jumped around for about ten or fifteen minutes after the set was turned on, then settled to its usual rock-steadiness.

According to an article in *QST*,[1] instability in the pto can be attributed to several factors, including capacitor C205, a 51-pF mica of the same type as those giving sensitivity problems. When I originally read the *QST* article, I assumed C205 might be changing value. However, after the previous experience with leakage, I found that a vtvm check between pin 1 of V15 and ground showed the telltale positive voltage.

After the set had been on for 10-15 minutes, the positive voltage disappeared, and the pto became stable. I suspect that, since a current flows through the capacitor when the pto is operating, the leakage path burns off after several minutes, then regenerates when the set is turned off. At

any rate, the pto remained stable after installing a new capacitor for C205.

audio response

I became increasingly annoyed by an emphasis on the bass of the audio response as both the 75A-4 and I grew older. I realize that as we grow older our ears become less sensitive to the higher frequencies, but retain their response to the lower frequencies, thus accenting the bass.

A newly acquired audio generator provided the opportunity to check the 75A-4 audio response. A surprisingly high peak (10 dB) appeared at 100 Hz, which decreased sharply on either side, to a level output between 300-3000 Hz.

Reference 1 suggested that feedback resistor R71 be removed. I tried this when I first read the article, but I didn't like the increase in audio, which required riding the af gain control; nor did I like the unpleasant audio quality.

The audio-signal generator showed that, with resistor R71 disconnected, the 100-Hz peak disappeared and the entire audio response became a broad peak centered around 3200 Hz. Substituting a 100-k resistor for the 33k originally used for R71 eliminated the objectionable 100-Hz peak and smoothed the entire audio response. A 1-meg resistor in series with the af gain control improved its action.

less bass response

Another source of bass emphasis is the cathode network associated with the noise-limiter diode, V 12. Since the limiter is useless for cw and ssb, I removed V 12 and inserted the leads of a 0.005-μF capacitor into the tube socket (holes for pins 2 and 7). This connects the detector output directly to the af gain control and eliminates the cathode network. If you would like even less bass, use a 0.001 μF capacitor.

reference

1. P. Rockwell, W3AFM, "Station Design for DX," *QST,* November, 1966, p. 53.

Albert G. Shafer, W4SD

the ham notebook

75A4 hints

To increase the amplitude of the 100 kHz markers on the 75A4, directly substitute a 6BZ6 in place of V1, the 6BA6 calibrator oscillator tube. If a further increase is desired, the oscillator 1-pF coupling capacitor, C5, can be replaced by a 10-pF silver-mica capacitor. The combination of the foregoing will result in a 20-dB calibration signal increase, as read on the S-meter, on the 14 MHz band. This was without any apparent degradation of the frequency stability as read on a General Radio model 1192 frequency counter.

For the convenience of having a front-panel ground of the antenna input circuit for testing, simply bend in the tip of the outside plate on the stator of the antenna trim capacitor, C18. This will short the antenna terminal to ground as the rotor passes over this one point. It means, however, that the trimming capacitor must be rotated from the opposite direction while in use. Full 360° rotation is no longer possible, but this loss is more than justified by the convenience.

M. H. Gonsior, W6VFR

ic power

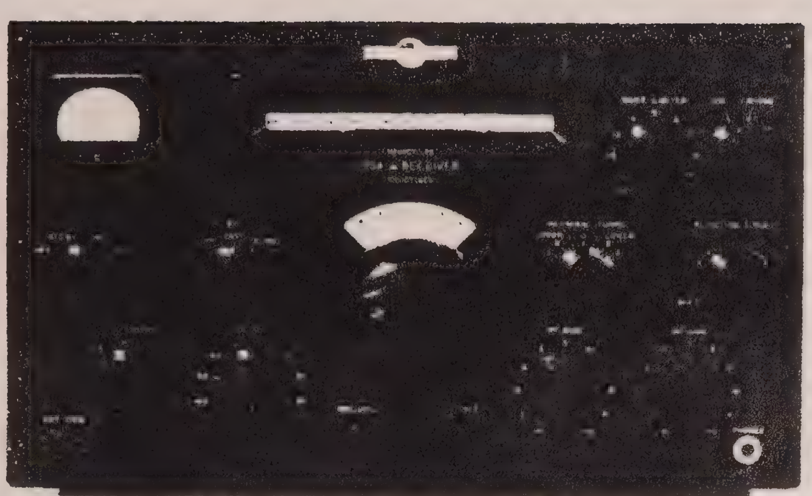
Too often, when radio amateurs start experimenting with IC packages we stop thinking like amateurs and start thinking by the book. A case in point was my own experience with a dual two-input gate which was used to build a Schmidt trigger. Briefly this is a circuit which will take almost any waveform provided it is above the needed trigger level and convert it into a form which can be used to trigger flip-flops.

The circuit was put together with an input voltage of about three volts, the output on the scope was a very nice square wave. Trying to trigger a series of flip-flops with this output was sheer frustration. Everything was wired properly, the supply voltage was on the money, but the flip-flop triggering was erratic. I finally decided to think like an amateur and measured the *output* of the Schmidt trigger and found that it was about 0.4 volts. I then powered the trigger with my variable voltage supply and found that at six volts dc applied to the IC, the output rose to 0.65 volts and the flip-flops triggered reliably. This circuit has been working very nicely for some months now with six volts, not the 3.6 as recommended. There have been no signs of failing or blowing up. Don't be afraid to think like an amateur!

A. S. Joffe, W3KBM

wet basement alarm

Having always been concerned about plumbing leaks in my basement hamshack, I finally whipped up a combination water alarm and shut-off circuit for my well pump. Sensors placed strategically around the basement (near the well pump, washing machine and hot water heater) trigger Q1 into conduction



making your Collins 75A4 perform like new

How to clean up the all-too-common tuning problems of an old but popular receiver

Paul D. Rockwell, W3AFM, Kenwood, Chevy Chase, Maryland 20015

Many amateur radio operators believe the Collins 75A4 to be the best amateur receiver ever made. Particularly for CW use, there is much truth to this. Unfortunately, the 75A4 is long out of production and—for some, at least—out of style.

Some of the reasons for this fine receiver's going out of style include: Size, weight and (relatively) high power consumption, old-fashioned appearance (black crackle, square corners), not set up for transceive operation, not equipped for break-in muting, vacuum tube instead of solid-state design, objectionably high noise figure, especially on 10 and 15 meters, and insufficient dynamic range and front-end selectivity.

Of these factors, the latter two are true of *all* receivers, no matter what their vintage, but the 75A4 actually does better with them than almost any current receiver! The noise figure and dynamic range problems have been attacked before,[1] and a good preamp can help the former at the expense of the latter. Another factor, one of the most frustrating and yet most easily overcome, is the age-connected problem of stiff tuning and

frequency jump. Solving this difficulty is the subject of this article.

The 75A4 is at its best as a CW receiver, and CW requires delicate and smooth tuning. As 7A4s age, however, many begin to get stiff and require irregular torque on the tuning knob and some may jump frequency a kHz or two even while not being tuned. Both of these problems have their cause in the permeability-tuned oscillator and dial assemblies. Many amateurs have learned to live with sticky tuning, at least up to a point, but frequency jump is intolerable. It is probably safe to say that these problems account for many of the 75A4s being offered on the market today.

Some discussion of the causes of frequency jump was given in the previously cited article. It is now believed that the two problems are inter-related, and that if sticky tuning is tackled first, the frequency-jump problem will usually disappear along with it.

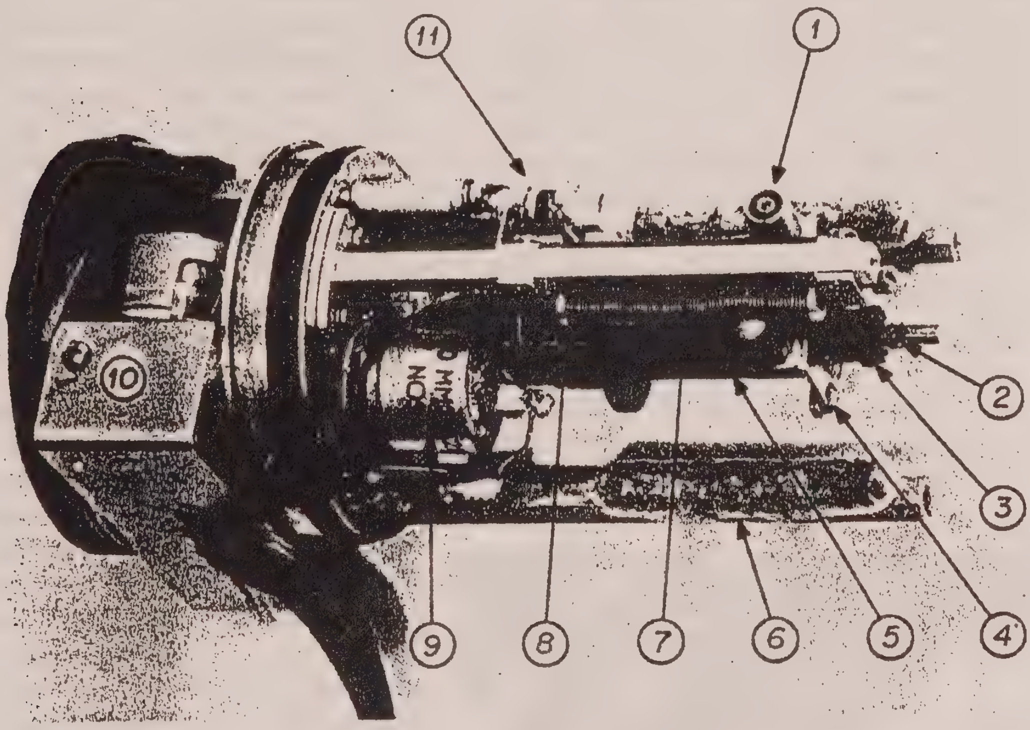


fig. 1. Inside the Collins 75A4 permeability-tuned vfo (PTO). The numbers identify the critical parts of the PTO assembly, described below.

1. Cam idler wheel, which rides on cam stack to control idler.

2. Lead screw, whose rotation moves the tuning slug through the tuning coil.

3. Lead-screw lubricating washer; should be saturated with oil.

4. Cam idler assembly, whose movement makes minor adjustments in oscillator tuning linearity.

5. Tuning slug.

6. Moisture-absorbing silica-gel sacks, blue when dry and pink when saturated.

7. Cam stack, used to compensate for non-linearities in oscillator tuning.

8. Tuning coil, wound with varying pitch to approximate linear tuning with slug travel.

9. Padding capacitor, which establishes oscillator tuning range.

10. Cover for tube bases and non-critical PTO components.

11. Trimming inductor, used to set the PTO tuning range to precisely one MHz for ten turns of the lead screw.

The bulk of the problem exists inside the PTO (**fig. 1**), and this is where you are going to have to go. Pay no attention to the manufacturer's caution about not breaking the seal of the PTO—these units were never hermetically sealed, even when brand new. They could breath through the bearings and, perhaps, the rubber O-ring. Moisture-laden air, breathed in a little at a time each time the receiver was turned off and cooled down, usually turned the silica-gel sack pink within the first year's operation—and that was a long time ago. If moisture is a worry, as it might be in a basement shack or in a particularly humid part of the country, you could let the receiver run around the clock (bad from the energy point of view). Better, install a 7½-watt, 115-volt pilot lamp near the PTO, wired directly to the power line, and let it run all the time to keep the PTO warm. At any rate, moisture is not a problem with 99.9% of the 75A4s around, but sticky tuning is present to some degree in almost all of them.

This operation will be a painful one for anyone who doesn't like working with tools. Assuming only the usual number of minor problems along the way, you can expect the complete job of removal, repair and reinstallation of the PTO will consume the better part of a day. If your time and patience are too thin, you might try a partial job—but then don't expect miracles.

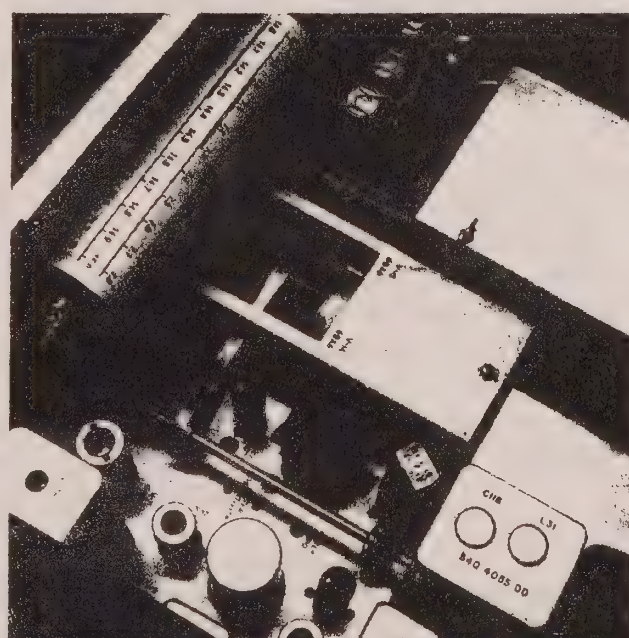
pto removal

The first step (after taking the receiver out of the cabinet) is to set the tuning dial to 14.000 MHz. Next remove the vernier knob, mounting plates, ring gear and pinion. Put the metal parts into a half-pint jar of mineral spirits to soak, or better, clean them in an ultrasonic cleaner if you happen to have one. Make sure all dried grease is removed before you take out the parts and dry them. Set up a row of saucers or ash trays so that all the small hardware can be placed in them in sequence as it is removed. This not only keeps them from getting lost, but is also a nice memory jogger when reassembly time comes.

From the top of the receiver remove the tuner dust cover, top and side screws of the PTO rear cover plate, and set screw and spring of the passband-tuning bronze band. Loosen the two set screws of the tuning shaft, immediately to the rear of the flexible coupling.

Remove the bottom plate from the bottom of the receiver. On the middle-bracing chassis cover plate remove the front two screws and loosen the rear two screws. This will permit the plate to be tilted so the PTO can be pulled out of its shaft coupler when the time comes. Make a sketch of the PTO connections and mark the chassis with a felt-tipped pen to facilitate reconnecting the wiring correctly when the unit is reinstalled. Unsolder the three power leads and the coax.

Pull out the PTO. The first thing to examine and repair is the tuning-shaft grounding wiper. This is the small L-shaped arm at the front, secured by two tiny Phillips-head screws. Its purpose is to provide a good ground return on the shaft



Inside the 75A4. The PTO is hidden by the square cover although the two 6BA6 oscillator tubes, V14 and V15, are clearly visible.

so that rf currents do not have to circulate through the front bearing. When the receiver is new, this wiper rides on the polished finish of the shaft. However, continued use may have caused the shaft to gall at this point—check it with your fingernail. Roughness here can be a major contributor to sticky tuning, so if the shaft is rough loosen the screws, bend the wiper slightly forward so it rides on a smooth portion of the shaft, and apply a touch of grease to the contact point.

lubricants

There are a lot of misconceptions about lubricants. For purposes such as this one, plain axle grease and *3-in-1 Oil* are well up on the list. Axle grease is not as strange a choice as it sounds, as pressures (i.e., pounds per square inch) at some contact points can become very high and axle grease is very good at staying put. For those who want something better than axle grease, Aero Shell 7 — a general-purpose aircraft grease—is excellent. However, it is hard to find, expensive, and sells in five-pound (minimum) cans. Shell calls it a "Microgel Diester Synthetic," and it has an operating temperature range of −100 to +300°F. Silicone grease is not good for this purpose because of its inferior high pressure performance.

inside the pto

Now comes the moment of truth! ignoring the red-lettered warning decals, remove the screws holding the PTO cover and carefully slide it off. Examine the PTO assembly, noting the locations of the various components identified in fig. 1. Drop a few drops of *3-in-1 Oil* on the front bearing, on the rear felt washer, and on the cam rollers. Put a dab of grease in the rear sleeve bearing (inside the rear of the PTO can). Rotate the tuning shaft back and forth a few times—it should be easy to turn at this point, even with greasy fingers. Work the cam followers in and out about an eighth-inch (3-mm) or so and lubricate them. Grease the cam surfaces. You can now replace the PTO cover.*

reassembly

Replace and reconnect the PTO. Oil the turns counter, located between the PTO and the front panel. It should be possible, from the front panel, to turn the dry shaft with bare fingers. Grease the vernier knob assembly, gears and bearings, and remount the knob. Reset the knob to 14000 kHz, using the crystal calibrator to make sure the receiver is actually *tuned* to 14000 kHz, and try it out. Feels like a new receiver, doesn't it?

frequency jump

If your 75A4 was one of those that suffered from this annoying problem before, it should be gone now. The explanation is that the cam follower in a dried out, sticky PTO no longer rode easily on the cam. Instead, when the cam pitch changed slightly the follower hung up on dust off the cam, later dropping into proper position and causing that annoying jump in frequency.

One final caution. Keep your eyes open, both inside the PTO and around the drive train and dial mechanism, for dried grease, dirt, metal chips, galled surfaces, loose rivets or screws, or misaligned shafts or bearings. These can all be taken care of much more easily now, when the receiver is all apart, than they can late some night during the middle of the DX contest!

*A previous article on servicing Collins 51J series PTOs[2] has several worthwhile suggestions that apply to Collins 75A-series receivers as well. One of these is to replace the relatively unreliable tubular ceramic bypass capacitors in the PTO with disc ceramics, an easy job with the PTO removed from the receiver. editor

references

1. Paul D. Rockwell, W3AFM, "Station Design for DX," *QST*, November, 1966, page 53.
2. William I. Orr, W6SAI, "New Life for the Collins 51J Receiver VFO," *ham radio* December, 1969, page 36.

ham radio

300-Hz crystal filter for Collins receivers

Jim Fisk, W1DTY, Ham Radio Magazine, Greenville, New Hampshire 03048

Recently a number of 455-kHz Collins crystal filters with a 6-dB bandwidth of 300 Hz have become available on the surplus market.* These filters, which were built to military specifications, have a 60-dB bandwidth of 1200 Hz and maximum insertion loss of 5 dB, are designed for a source and load impedance of 2000 ohms, and do not require any resonating capacitors† (mechanical filters for Collins receivers are designed for terminations of 50 kilohms or greater and require external capacitance to resonate the transducer coils). If the crystal filter is not terminated with 2000 ohms, passband ripple will be on the order of 6 dB or more and spurious response will seriously degrade skirt selectivity.

Since the filters in Collins receivers are isolated by dc blocking capacitors, the required terminations for the crystal filter are most easily provided by simply connecting 2200-ohm resistors across the input and output terminals. Be sure to remove the 100 pF resonating capacitors from the circuit, however, as they will cause excessive passband ripple and unwanted spurious response. When terminated with 2200-ohm resistors passband ripple is nil and the skirts roll off smoothly to 80 dB or more.

Unfortunately, however, this simple resistive loading results in a serious impedance mismatch which manifests itself as 10 to 12 dB of additional circuit loss. Increasing the terminating resistors to 3900 ohms will reduce the loss about 3 dB, but passband ripple starts to suffer. A better solution is to drive the crystal filter with the simple emitter follower circuit shown in **fig. 1**. This circuit, which requires only 10 mA of current, reduces circuit loss to 3 dB or less and provides the filter with the required source impedance.

The emitter follower can be built on a small section of perforated circuit board which is supported by the input and output wiring. Power is derived from the screen circuit of the mixer tube. Make sure that the emitter follower is properly isolated with dc blocking capacitors as any dc voltage on the filter transducers will damage them (the filter switch has shorting contacts, so any voltage on the switch may damage adjacent filters as well). However, if you follow the circuit shown in **fig. 1**, which is completely isolated, you will have no difficulties.

Installation of the filter in 75S3B and later model S-line receivers requires only a length of number-20 (0.8mm) tinned bus wire, a lockwasher, and a 4-40 nut. The filter is installed below the chassis, on one side of the filter shield compartment, as shown in **fig. 2**

*The Collins 300-Hz crystal filters, X455KF300, with data sheets, are available from Gary Fertik, W1EBC, 40 Pilgrim Trail, Woodbury, Connecticut 06798. Price is $49.95, postpaid.

†XF455KF300 filters, Collins part number 526-7073-010. Other Collins crystal filters with the same generic nomenclature but with different part numbers are designed for 20k terminations; some require external capacitors. Although the filter described here is the most common, check the data sheet which comes with your filter.

(installation suggested by WA8OBG). Three holes are required: two for the electrical terminals and one for the mounting screw. Since these holes are below the chassis the filter installation does not deface the receiver.* The filter is symmetrical so either end may be used for the input or output.

Collins 75A4

Owners of Collins 75A4 receivers should be particularly interested in the 300-Hz crystal filter as the narrowest bandwidth filter designed specifically for this receiver has a 3-dB bandwidth of 500 Hz, and these filters are very difficult to find on the open market. Although there are two methods of installing the 300-Hz crystal filter in the 75A4, the installation shown in the photograph is recommended because it provides maximum isolation between the input and output (this same method is also recommended for Collins type-FA mechanical filters).

Turn the 75A4 upside down on your bench (front panel forward) and remove the bottom cover. The three filter sockets are in the front right-hand corner next to the selectivity switch. The crystal filter is installed in the shield which crosses the three filter sockets. Two 1-inch (25mm) deep slots must be cut in the shield as shown in **fig. 3.** Use *sharp* tin snips and place rags underneath the work area on both sides of the shield to catch any debris. After cutting the slots, bend the tab toward the rear of the receiver so it forms a 90-degree angle with the shield. A hole for the filter mounting screw is drilled in the center of the tab, ¼ inch (6mm) from the end (the threaded stud on the other end of the filter is not used).

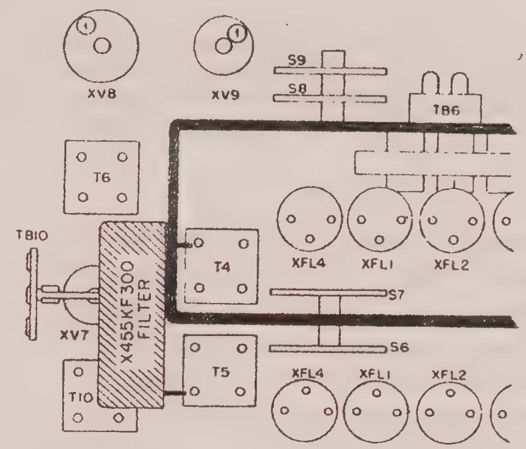


fig. 2. Installation of the Collins X455KF300 crystal filter in S-line receivers.

After the tab is finished, temporarily set the filter in place to check for clearance between the top of the filter and the bottom cover of the receiver (if you follow the dimensions shown in fig. 3, the top of the filter should be approximately flush with the top of the shield).

Locate the input and output wires to filter socket A (underneath switch S2) and their respective connection points on the switch wafers (note that one of the wires is grounded). Remove the two 100-pF resonating capacitors. Install the emitter follower circuit shown in fig. 1 between switch S2 and the crystal filter. The emitter follower common is con-

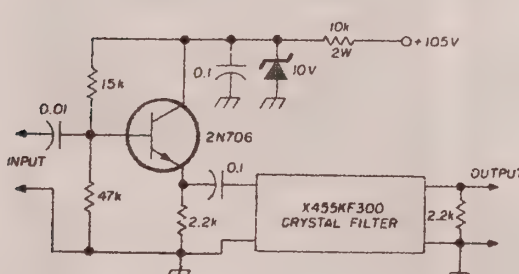


fig. 1. Emitter-follower circuit which provides correct source impedance for the crystal filter and minimizes circuit loss. Most general-purpose npn transistors may be substituted in the circuit.

*In *some* Collins 75S3B receivers there is sufficient clearance under the filter shield on the top of the chassis that the crystal filter can be installed in the existing crystal-filter sockets. Although the terminals of the X455KF300 will not fit the sockets, short lengths of no. 20 (0.8mm) wire can be soldered to the filter terminals and plugged into the sockets.

nected to the grounded terminal on the rear wafer of S2; the input coupling capacitor, C1, is connected to the other switch terminal which goes to filter socket A. Install two short lengths of number 20 (0.8mm) bus wire to each of the connection points on the front wafer of switch S2. (If you don't want to include the emitter follower, connect bus wires to the rear wafer as well.)

Connect a 2200-ohm resistor across the output terminals of the crystal filter and install the filter on the mounting tab using a lockwasher and 4-40 nut. Wire in the emitter follower and solder the two bus wires to the output terminals. Total installation time should be two hours or less.

Since you have the bottom of the receiver open, this is a good time to apply some contact cleaner (such as GC Electronics *Tunerlube*) to each of the switch contacts. It's also a good idea to dab some silicone grease on the switch detent mechanisms. If your 75A4 is like most, the only lubrication the receiver has ever seen was applied at the factory, and that's pretty well dried up. A little switch care now may save an expensive replacement problem later.

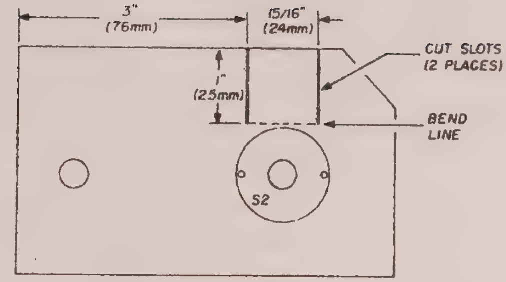


fig. 3. Collins 75A4 filter shield, showing modifications required for installing the crystal filter. Completed installation is shown in the photograph.

An alternative method is to mount the crystal filter on a small L-shaped bracket which is attached to the chassis with the screw which holds the left-hand end of the filter shield (next to the i-f gain control). In this case the filter connections are made to filter socket C. However, this method is not recommended because the connecting wires are quite long and lowered input-output isolation degrades the high skirt selectivity of which the filter is capable.

operation

If another mechanical filter is installed in filter socket A, it must be moved to socket B or C. Operation of the 75A4 with the sharp 300-Hz filter requires some practice to gain full advantage of its high skirt selectivity. The setting of the *passband tuning* control is quite critical and for best results should be set so that CW signals peak at a pitch of about 700 Hz. When you tune in a signal with a broader filter, set the main tuning for a 700-Hz note before switching the sharper 300-Hz filter into operation. If the signal is tuned for a higher or lower note (assuming the passband tuner is set for 700 Hz), the receiver must be retuned slightly to find the signal. With a little practice, you'll find that the narrow bandwidth and high skirt selectivity of this filter do an excellent job of cutting interference or digging into the noise for weak signals.

ham radio

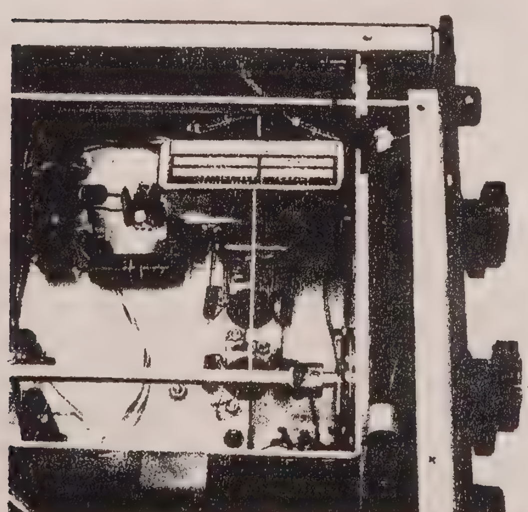
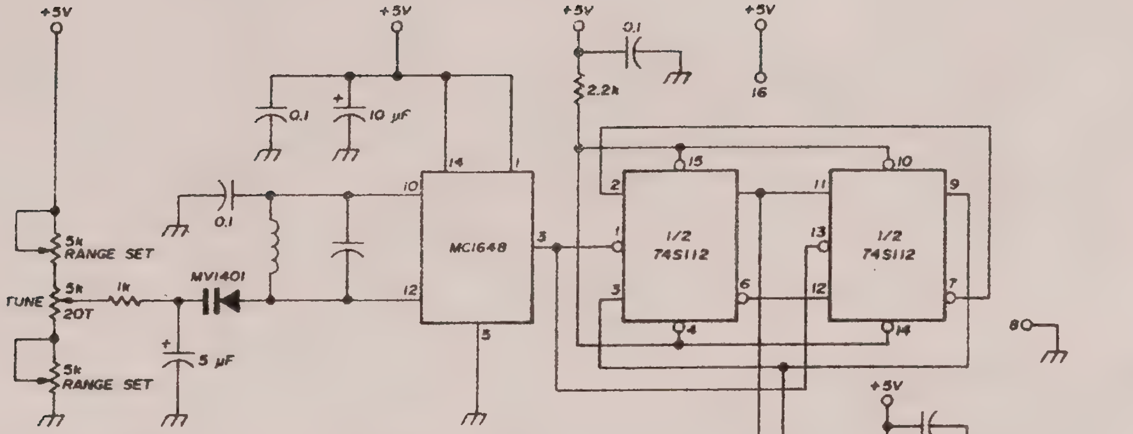


fig. 4. Crystal filter installation in the Collins 75A4 receiver. The emitter follower is on the small circuit board to the left.



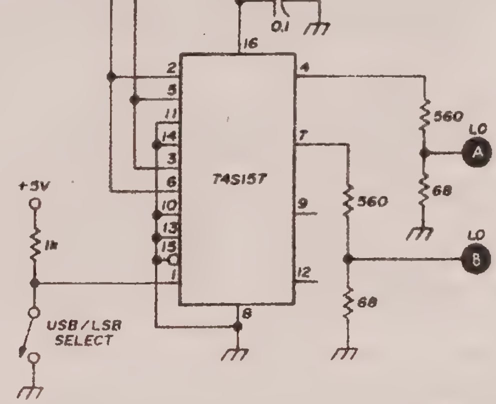


fig. 2. Schematic of a direct-phasing quadrature local oscillator designed for a direct-conversion 80-meter receiver. Timing sequence is shown in fig. 2.

section most interesting. The diagram of a quadrature-phased local oscillator I have been working on for use in a 3.5- to 4-MHz receiver is shown in fig. 2. As the timing diagram (fig. 1) demonstrates, the design is free of asymmetry errors since it is responsive to the negative-going transition of the clock waveform, and the clock may exhibit any periodicity it wishes, within device limitations. The circuit was intended for use with MC1496-type product detectors and has provision for switching the phase of the local oscillator to effect sideband reversal rather than performing the task at audio and having to accept a compromise in unwanted sideband rejection.

Douglas K. Beck, K6ZX
Sunnyvale, California 94086

Collins 75A4 mods

Dear HR:

Recently, when the avc failed in my Collins 75A4, the usual changing of tubes had no effect. Actually, a small amount of avc action remained – the S-meter needle rose slightly off zero with very strong signals. The trouble proved to be R86, a 39k resistor. Both R86 and R87 had suffered severe overheating – R86 had changed in value from 39k to approximately 3k, causing overheating of R87 and eventual failure of the avc.

My 75A4 manual lists R86 as a half-watt resistor. However, a friend has a later 75A4 manual, and it shows a rating of one watt (the serial number of my receiver is in the 2500 series). If you experience avc failure in your 75A4, first check R86 and, if you're working on the receiver anyway, make sure that R86 is a one-watt resistor.

Incidentally, I cannot recommend too highly the 75A4 mixer mods described by W6ZO in *ham notebook*. I installed them over a year ago and have been extremely pleased with the results. I also changed the first rf amplifier from a 6DC6 to a 6GM6 as recommended by W2VCZ, and recommend that, too, as it increases gain and sensitivity. However, I would not plug in the 6GM6 without first installing the W6ZO mixer modifications.

Bob Locher, W9KNI
Deerfield, Illinois 60015

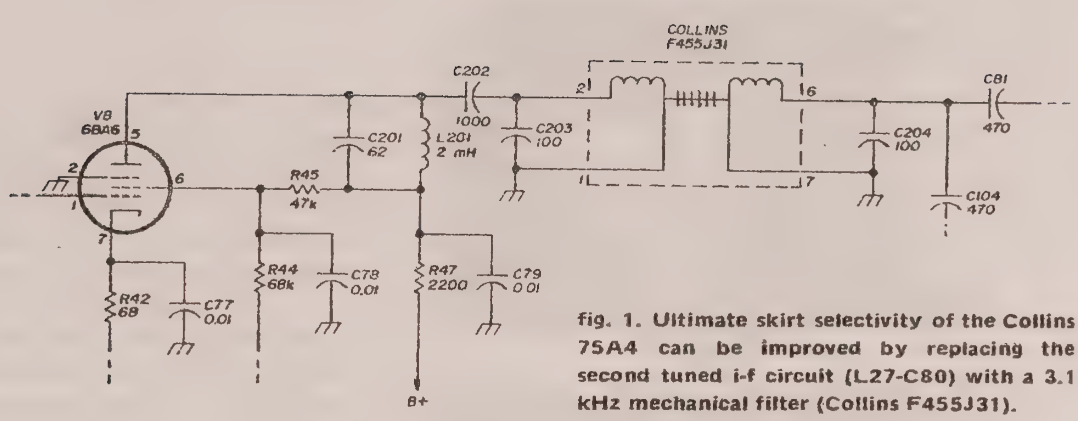


fig. 1. Ultimate skirt selectivity of the Collins 75A4 can be improved by replacing the second tuned i-f circuit (L27-C80) with a 3.1 kHz mechanical filter (Collins F455J31).

headphone cords

For some time I have tried to purchase replacement earphone cords for my headphones. Over one dozen New York merchants told me they didn't stock them.

Various alternatives (including four-wire rotator cable) were tried, but none of them were satisfactory. If you are faced with a similar problem I would suggest trying Trimm, Inc., for suitable replacement cords.

I tried both their no. 811, standard pin tip terminals, black cotton braid, 4½ feet (1.4m) long; and their no. 870, similar but 5 feet (1.5m) long with a waterproof outer braid. Costs range from $2.00 plus postage. A card to Trimm, Inc., Post Office Box 489, Libertyville, Illinois 60048 could save you a lot of exasperation.

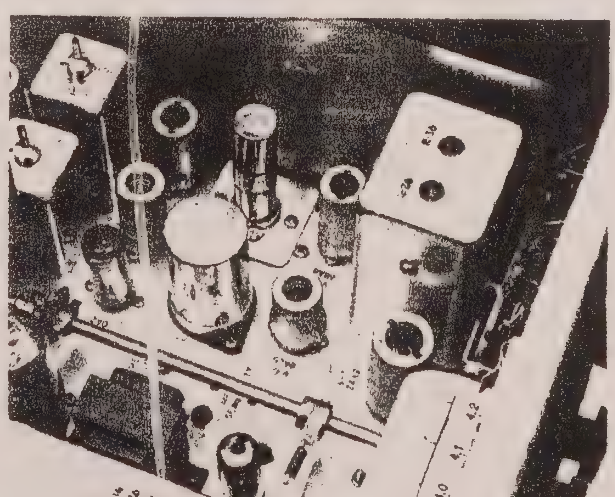
Neil Johnson, W2OLU

increased selectivity for the Collins 75A4

The ultimate skirt response of the 75A4 selectivity curve can be improved considerably by replacing the second 455-kHz i-f amplifier tank circuit (L27-C80) with a 3.1-kHz Collins mechanical filter (F455J31) as shown in fig. 1 (modification suggested by W4ZKI). Since most amateurs who use the 75A4 for ssb operation have replaced the original 3.1-kHz filter with a 2.1-kHz filter, the 3.1-kHz unit is seldom used. If a 3.1-kHz filter is not available, a 4.0 kHz filter (F455J40) will still provide a noticeable improvement in skirt response. The L27-C80 tuned circuit is in the i-f can next to the filter capacitor, C94.

Remove the bottom panel of the receiver, disconnect all the leads which go to the L27 i-f can, and remove the two retaining nuts (don't discard the i-f can — you may want to restore the receiver in the future). Cut out a small piece of thin aluminum, 1-3/4 inch (4.4cm) square, and punch a 3/4-inch (2cm) hole in the center for a 9-pin tube socket. Drill the two chassis-mounting holes and position the tube socket so pins 1-2 and 6-7 are aligned with them. Install the

Filter installation in the Collins 75A4.



socket on the plate and fabricate a small brass shield about 5/8 inch (1.6cm) high. This shield is placed across the tube socket between pins 3-4 and 8-9 and soldered in place (see mechanical filter sockets A, B and C for reference). Ground all unused socket pins.

Wiring the new filter into the circuit is straightforward and requires only four mica capacitors and one inductor. (C201-C204 and L201 in fig. 1). Install the two 100 pF filter resonator capacitors at the input and output socket pins (the filter is symmertical so either set of pins may be used as the input). Install a small terminal strip next to V8 for the junction of R45, R47, C70, C210 and L201. Delete C69 and R46 as they are not used in the new mechanical filter circuit.

An improvement in i-f gain can be obtained by removing resistor R29 from the plate circuit of V6. This resistor swamps out the Q of L24 and increases the bandwidth for a-m reception; it is not required for ssb or CW operation.

Jim Fisk, W1DTY

muting microphones

Other amateurs must be faced occasionally with the same problem I was: that of disturbing others in the household when talking into a microphone. Headphones, of course, eliminate any speaker disturbance. The microphone problem was solved by attaching a heavy-walled cardboard tube (of the proper diameter) about 3 inches (10cm) long to the face of the microphone, making sure the joint is completely sealed. By pressing your lips into the open end of the tube, and speaking in a whisper, no sound can be heard in the shack. The fact that the voice is completely retained within the tube compresses the sound, resulting in increased talk power, although it may sound like you're in a barrel. Microphone gain must be reduced considerably.

Ralph Cabanillas, Jr., W6IL

zener diodes. For the serial number, three numerals are used for entertainment types; one letter — X, Y or Z — plus two digits indicate industrial types. The AF117, for example, is a small-signal germanium rf transistor for entertainment purposes; the BCZ11 is an industrial silicon audio transistor.

original which used the optical coupler. In his circuit W2CQH also used a short piece of miniature coaxial cable for the 1-turn output link -- the outer shield is grounded only at the coaxial connector so the braid acts as a Faraday shield, eliminating any capacitive signal (and noise) pickup from the circuit.

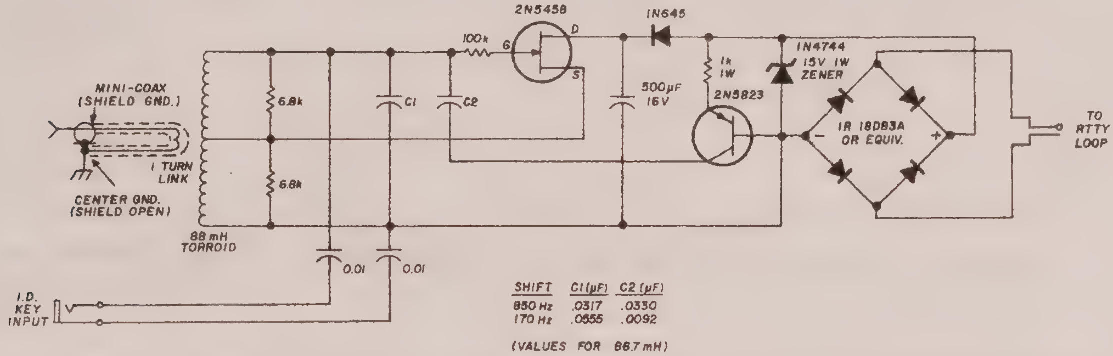


fig. 7. W2CQH's modification of W2LTJ's simple audio-frequency keyer uses silicon pnp transistor switch instead of an optical coupler. Shield on 1-turn coaxial loop acts as Faraday shield.

audio-frequency keyer for RTTY

Several readers have had difficulty obtaining the MOC1002 optical coupler which was used in the simple audio-frequency RTTY keyer described in the August, 1975, issue of *ham radio*.[3] W2CQH faced this problem and solved it with the silicon pnp transistor switch shown in **fig. 7**. Author W2LTJ has also built this version of the circuit and reports that it works as well as the

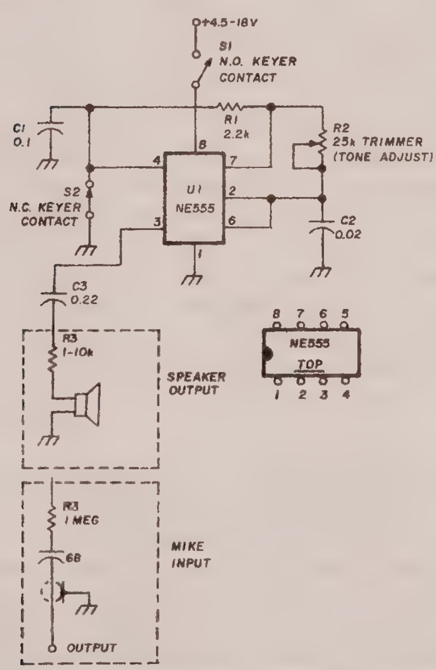


fig. 8. Autopatch keyer oscillator is based on NE555 IC timer. Either normally-open or normally-closed keyer contacts may be used to activate the oscillator. Line to microphone input must be shielded.

keyer oscillator

Shown in **fig. 8** is a circuit for a simple keyer oscillator submitted by KH6IHT and KH6IEL which they designed for autopatch use. Since the autopatch system in their repeater has a decoder bandpass from 2980 to 3080 Hz, R2 is adjusted to 3042 Hz for best results. However, R2 can adjust the output tone over a rather wide audio range for other applications. Two output options are available: speaker or microphone (the microphone input line must be shielded). R3 is adjusted for the required output/input level and may be replaced by a variable resistor, if desired. Normally-closed keyer contacts can also be connected between pin 7 of the NE555 and ground. A 9-volt transistor radio battery (NEDA 918) is recommended for the oscillator.

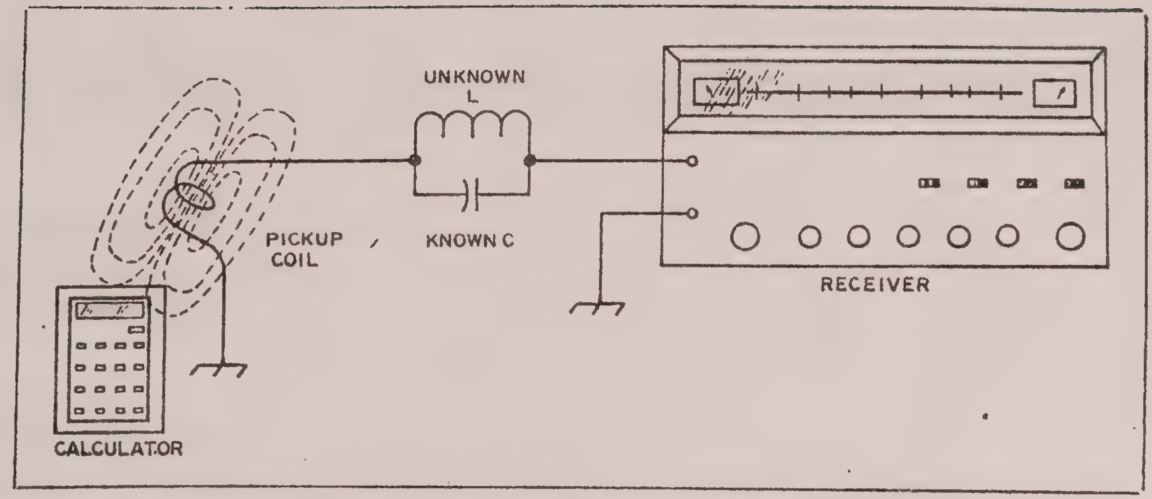
75A4 noise limiter noise

Some time ago W4ZKI mentioned to the editor that the 6AL5 noise limiter in Collins 75A4 receivers tends to be regenerative, contributing unwanted noise to the receiver. Since the noise limiter is not too effective on ssb or CW, and few operators use it, W4ZKI recommended that the circuit be disabled and the tube removed. This information was passed along to W9KNI who solved the problem very neatly by removing the 6AL5 and plugging in a jumper between pins 2 and 7. On my 75A4 this simple modification reduced the no-signal noise level by about 3 dB, a worthwhile improvement.

references

1. Frank Regier, OD5CG, "Simple Audio Lowpass Filter," *ham radio*, January, 1974, page 54.
2. Bill Wildenhein, W8YFB, "Inexpensive Audio Filters," *ham radio*, August, 1972, page 24.
3. Bill King, W2LTF, "Simple Audio-Frequency Keyer for RTTY," *ham radio*, August, 1975, page 56.

ham radio



Rf noise generated by a calculator LED readout circuit may be used in this manner for determining unknown L or C values.

LONG-WAVE CONVERTER

The simple long-wave converter I have built provides surprisingly good results. At Hilton Head Island, SC, I receive bc signals on 164, 180 and 185 kHz plus the San Francisco SFI on 192 kHz. The converter tunes down to 10 kHz.

A random-length wire or vertical antenna will furnish adequate signal pickup. I do not recommend a loop antenna.

As the diagram indicates, the output of the converter is in the range of 7.0 to 7.5 MHz. This is fed to the input of my Tempo One receiver. The oscillator is an International Crystal OX-1 set for 7 MHz. I find that almost any diode type may be employed in the circuit as a substitute for the 1N34. In order to avoid stray rf pickup, the diode cathode should have a short lead connected to the output jack.

For the inductors, I suggest using Miller part nos. 9002, 9004 and 9006. A standard 2.5-mH inductor will provide resonance for a random length wire in the vicinity of 180 kHz. Some experimentation with capacitance and resistance values should result in peak performance. — *David Curry*

COLLINS OSCILLATOR DROPOUT

Because of hf-oscillator dropout in my Collins 75A-4 when operating on the 10-meter band, I presented the problem to the engineers at Collins Radio and also to Bob Cerrick of Telcom. They recommended that the following checks be made. The second of these mainly resolved the erratic situation in my receiver, for the B+ voltage was low. A lower value resistor, substituted for R21, restored the correct voltage to pin 6 of V4.

1) Check first-mixer tube V3 (6BA7) and crystal-oscillator tube V4 (12AT7).

2) Measure the B+ voltage at pin 6 of V4 (12AT7). It should be +175 V.

3) Test cathode bias resistors R17 and R18, which should be fairly well matched.

4) Locate the 12AT7 ground connection where R17, R18, R20 and the filament mate. Remove the ground lug and install a good-quality no. 4 internal- or external-tooth lockwasher between the chassis and ground lug. Zinc-plated types are best for this purpose, but other types will work as well. Carefully clean parts, assemble and tighten.

5) Find the ground connections for the 6BA7, R13, R14, C35, C36, R16 and filament ground. Repeat the lockwasher installations as with the 12AT7.

6) If oscillator alignment is necessary, follow the instructions in the Collins manual (page 5-3, item no. 9). — *Charles Preston, K4LJH*

CALCULATOR NOISE HELPS FIND LC VALUES

The value of an unknown microhenry inductor, including toroids, or of a picofarad-range

An easily built long-wave converter. The local oscillator is an International Crystal Manufacturing Company OX-LO or OF-1-LO. L1, L2 and L3, respectively, are J. W. Miller adjustable wide-range inductors nos. 9002 (0.180 to 0.800 mH), 9004 (2.10 to 8.00 mH) and 9006 (12.0 to 40.0 mH). A 2-pole, 3-position rotary switch is used for S1. S2 is a general-purpose, single-pole, three-position switch. The 7.0- to 7.5-MHz output of the converter is fed through coaxial cable to a shortwave receiver.

Collins 75A-4 Modifications

by William H. Beatty, K7CMS
4721 N. Bamboo Circle
Tucson, AZ 85749

Improved Audio

This modification removes inverse feedback between the plates of the 1st and 2nd audio stages and changes inverse feedback originating at the output transformer secondary from the 1st audio to the 2nd audio cathode. Note: a further improvement can be made by changing to a larger audio output transformer and by trying different amounts of feedback by varying the value of R71.

Remove R71 (33k) from pin 3 of V13 (12AT7) and move to pin 8.
Reverse primary leads of audio output transformer (T5).
Remove R109 (390k) and discard.
Add 470k between C100 (.01) and pin 7 of V13 (12AT7)

Reduced SSB Distortion

This reduces the level of IF signal injection to the product detector
Replace C87 (10 pf) with 5 pf.
Add 50 pf in parallel with C99 (100 pf)

Improved Slow AVC

This increases the slow AVC time constant. It also reduces the AVC attack time and allows the AVC voltage to drop instantaneously when switching to standby.

Remove R90 (2200 ohm) and C112 (.1 mfd) and replace with 22k and .47 respectively, but with the bottom of the .47 mfd connected to junction of R98 (22k) and R104 (270 ohms) instead of to ground.

Connect .001 mfd from the junction of R89 (10k) and former R90 (22k) to ground.

Change C20 (.1 mfd) to .01 mfd.

75A MODIFICATIONS

A previous article spoke of receiver design in general terms[1] but this general tone may not have answered the needs of many receiver owners. While it is impossible to discuss each receiver specifically, perhaps a detailed commentary on the 75A-2 and 75A-3 with special emphasis on improving performance might be in order. Since the production of the first 75A-2, some three and one-half years ago, there have necessarily been a number of changes. As pointed out in the previous article, receiver design is one of compromise of conflicting factors in some respects. A change of viewpoint sometimes causes revision of circuits to effect a new compromise. Another reason for modification is the need for improvements to keep a design abreast of the state of the art. Yet another reason for circuit change is lack of consideration of production variations and engineering error, but it is very hard to get any engineer to admit the latter.

The first 75A-2 receivers used a 6AK5 tube as the RF stage. This tube is very good from the standpoint of sensitivity, but since it has a sharp cut-off characteristic, it is not suitable in this application if the receiver is subject to strong signals on adjacent channels. It tends to cross modulate at lower levels than desirable. It was changed to a 6CB6, as shown in Figure 1, to get greater freedom from cross modulation. To make this change, see Appendix 1.

A recent tube development offers even greater freedom from receiver malfunctioning in the presence of strong interferring signals. This tube is the type 6DC6 or 6BZ6 which was developed to meet the same problem in television receivers. This tube when added to the 75A lineup really shows a great improvement. At the present time the 6DC6 as an RF stage offers a much better perfor mance in a strong signal area and yet possesses a good noise figure. The circuit diagram for the 6DC6 or 6BZ6 is shown in Figure 3 and conversion instruc-

tions are given in Appendix 2.

Now that a good front end tube is available, what is the next step if this is not enough? If the receiver still suffers from cross modulation, an RF attenuator can be used. Try the circuit of Figure 3 between the antenna and the receiver antenna input terminal. As pointed out in the previous article, if both signals are well above the noise level, the loss in the antenna lead-in will not hinder reception of the desired signal. In fact, AVC will bring up the gain so that it is almost impossible to detect a change in audio level when receiving AM signals. Thus the resistive RF attenuator can offer improvement in receiver characteristics in most cases. If maximum receiver sensitivity is needed, as in the case of DX reception, there is no satisfactory solution except added RF selectivity. RF selectivity can come only from large low loss coils which are not practical in a receiver. The transmitter antenna coupler, however, does meet the requirements for good selectivity because ordinarily high Q coils are used to prevent loss of transmitter power. It is logical then to use the antenna coupler both for transmission and reception if one is available in the station.

For a better signal-to-noise ratio, generally, do not forget the value of a beam antenna. A beam with its high gain and directivity together with a low noise pickup coaxial receiver line adds up to better signals at the receiver antenna terminals. The front-to-back ratio of the beam antenna also helps discriminate against strong signals off the front of the beam. If man-made noise is very bad, a receiver AC line filter may help.

One circuit problem facing every receiver designer is mixer noise. In the 75A-2 a 6BE6 was used for both first and second converters as has been common practice in the past. Upon checking further into mixer noise level, it was found that the 6BA7 pentagrid mixer had less mixer noise than the 6BE6. The tube replacement was made in the 75A and overall receiver performance

improved. Unfortunately, the 6BA7 requires some blacksmith work on the chassis since the seven-pin sockets must be replaced by the nine-pin version. See Appendix 3 and Figure 4 for this modification. A further modification resulting from extensive tests was an increase in mixer bias level by changing R-7 in V-2 mixer cathode from 68 to 180 ohms. This change refers to the 6BA7 mixer only.

When it became evident that the mechanical filter contributed so much to the amateur receiver performance, it was decided to modify the set to secure the improved selectivity. The revision took the form of an adapter chassis occupying the same space previously taken by IF transformers T-4 and T-5. This simple adaptation permits amateurs in the field to take advantage of the better selectivity now available through the use of a mechanical filter without a difficult rebuilding job. See Figure 5 for new circuit and Appendix 4 for modification instructions. The adapter chassis was designed with an added amplifier V-18 to compensate for the 23 db insertion loss of the original mechanical filter. The loss in the mechanical filter upset the gain distribution of the set so that V-18 tended to add noise to the set and a slightly degraded noise figure was present on some sets. By removing R-78 and grounding the cathode of V-18, a reduction of internal receiver noise results.

When a new mechanical filter with 12 db insertion loss became available, loading resistors (R-81) across the grid circuit of V-6 (R-83) at the output of T-6 were added. Filter tuning capacitors were also changed when the low loss filter replaced the high loss element. See Figure 6.

If you receiver has been in use some time, it is wise to check the tubes and touch up the trimmers as explained in the instruction book. These routine tests will insure that peak performance of the receiver is maintained. This is, of course, a good practice in any receiver.

It was found that the shape of the 75A IF selectivity curve could be somewhat improved by stagger tuning the IF transformer. This effectively peaks the

corners of the IF pass band resulting in less rounding of the corners of the pass band than afforded by the mechanical filter by itself. Instructions for the revision and realignment to accomplish this result will be found in Appendix 4.

It is desirable, from the standpoint of maintaining the audio output level nearly constant during fades, to obtain a flat AVC characteristic, with the AVC threshold occuring at levels of 1 to 2 microvolts.

This flat AVC characteristic has the undesirable effect of increasing the audio output when the receiver is detuned from a signal or the received signal goes off the air. This difference in level is due to the noise appearing as a highly modulated signal with a very small carrier component. Because the AVC time constants will not charge sufficiently on noise to hold down the set gain, the overall result is an increase in audio output over what was obtained with the received signal. To aggravate this situation, many amateur signals are not 100% modulated and as a result, the difference between the audio output on a signal and noise between signals is further increased.

One solution to this problem is to back down the RF gain control to a point where the noise between stations is not objectionable but where there is still adequate receiver gain. It should be noted that when this is done, the S-meter reading for a given signal will not change appreciably unless the signal level approaches the AGC threshold level.

When tuning signals which are very weak, however, it is advisable to operate the RF gain control wide open for maximum sensitivity.

It is hoped that these comments and modification instructions will be of assistance to receiver owners.

APPENDIX I

Revision from 6AK5 to 6CB6 RF amplifier.

1. Connect jumper between pins 2 and 7 of V-1 socket.
2. Revise value of R-65 from 1 megohm to 1.5 megohm.
3. Replace 6AK5 RF amplifier tube with type 6CB6.

APPENDIX III

Conversion of 75A-2 to replace 6BE6 mixers with 6BA7's.

1. Carefully unsolder pin connections of V-2 and V-4.
2. Remove 7-pin sockets and ream out holes to 3/4" for clearance of 9-pin sockets. Be sure that all loose chips are removed from set, especially around band switches.
3. Mount new tube sockets. Orient V-2 so that pin 7 is closest to RF amplifier. Orient V-4 so that pin 2 is closest to crystal oscillator tube (V-3).
4. Wire sockets per schematics in Figure 4, being sure that all grid and plate leads are as short as possible and that all grounds are returned to the same point that they were made in the original setup.

Revision of 75A-2 to use 6DC6 or 6BZ6 RF Amplifier to Improve Cross Modulation Characteristics.

All resistor tolerances ± 10% unless otherwise marked.

1. Replace 6AK5 or 6CB6 with 6DC6 (V1).

2. Remove R-66 (120 ohms) and C-106 (cathode bypass), tie pins 2 and 7 of V1 to ground.

3. Remove R-65 (1.5 megohm). (Some sets may use 1 megohm).

4. If V2 and V4 are type 6BE6, replace with type 6BA7 as shown in Appendix III.

5. Check value of R-11, if it is not 10K, change to 10K.

6. Fasten 2 terminal tie point to L-24 mounting lug.

7. Remove R-21 and C-61 from terminal A of L-24 and fasten to tie point.

8. Ground terminal A of L-24.

9. Remove coax lead from terminal F of L-24 and fasten to tie points.

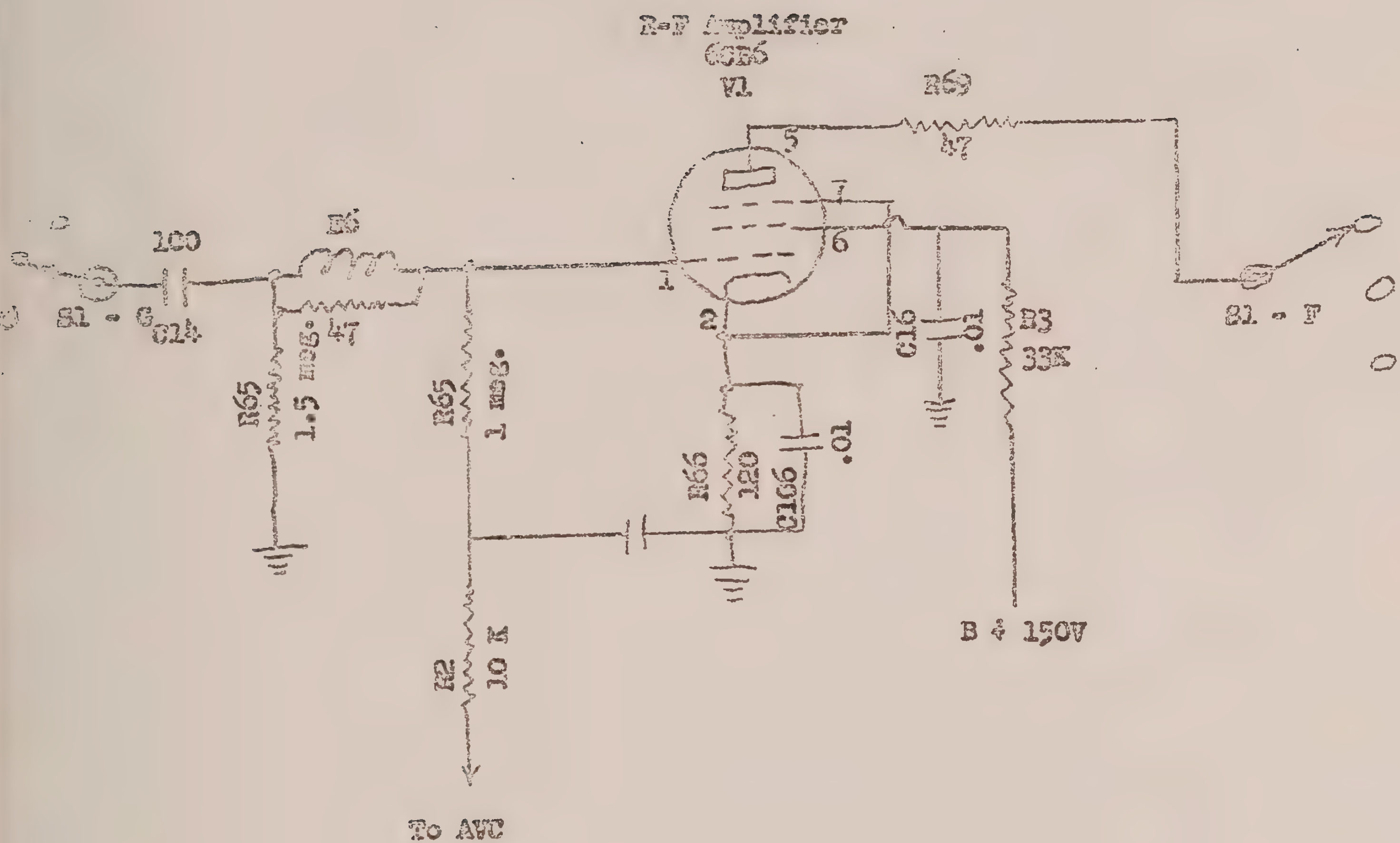
10. Connect 470 uuf mica capacitor from terminal F of L-24 to center conductor of coax cable, and 2.2 meg from junction of center conductor of coax cable and 470 uuf capacitor to junction of C-61 and R-21.

11. Connect 820K from junction of center of coax cable, 470 uuf, and 2.2 meg resistor, to ground.

12. Incorporate revisions shown in Appendix V.

Figure 1

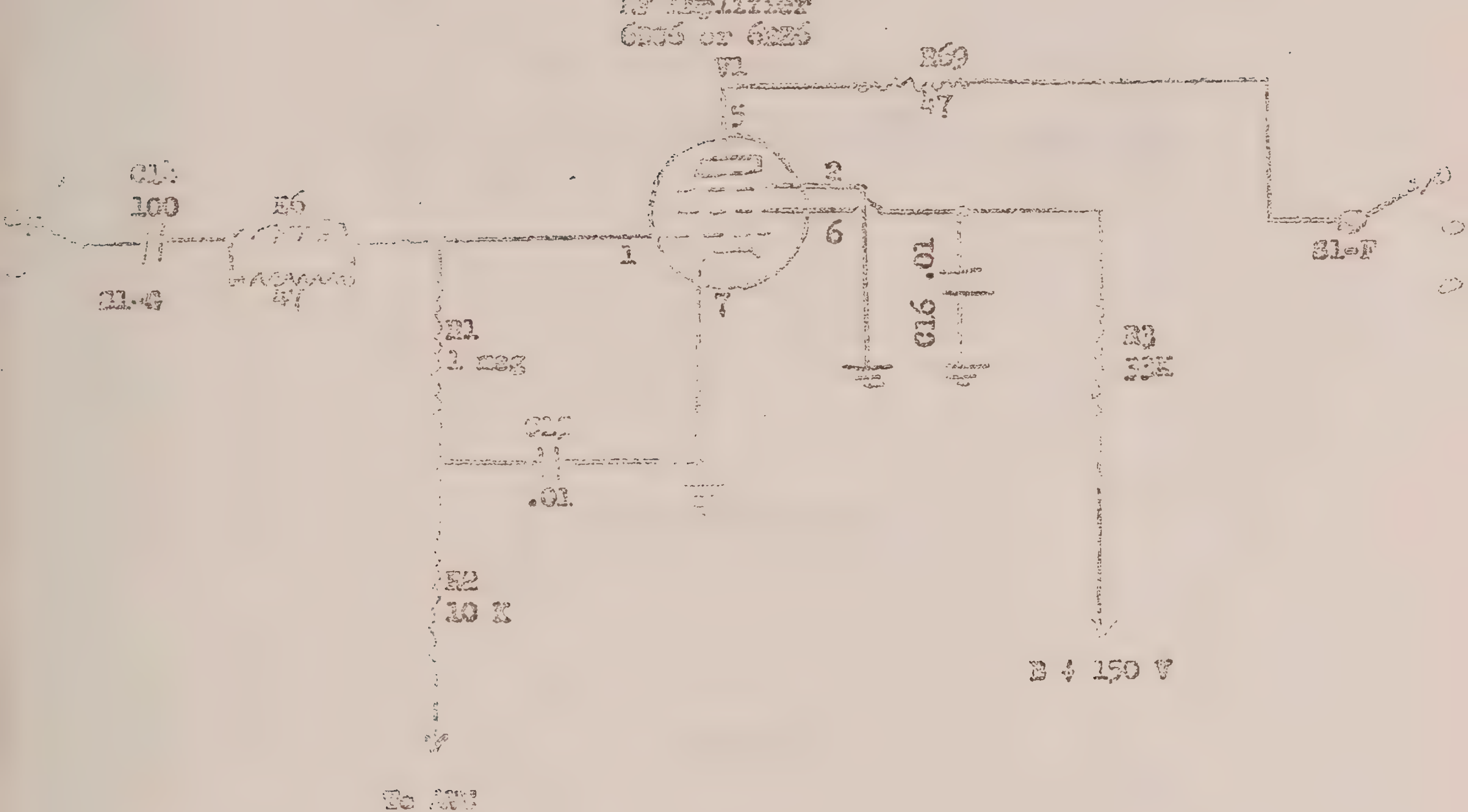
6CB6 RF Amplifier



NOTE: All resistors
10% tol. 1/2 watt
See Appendix 1

FIGURE 2

6BZ6 or 6DC6 RF Amplifier

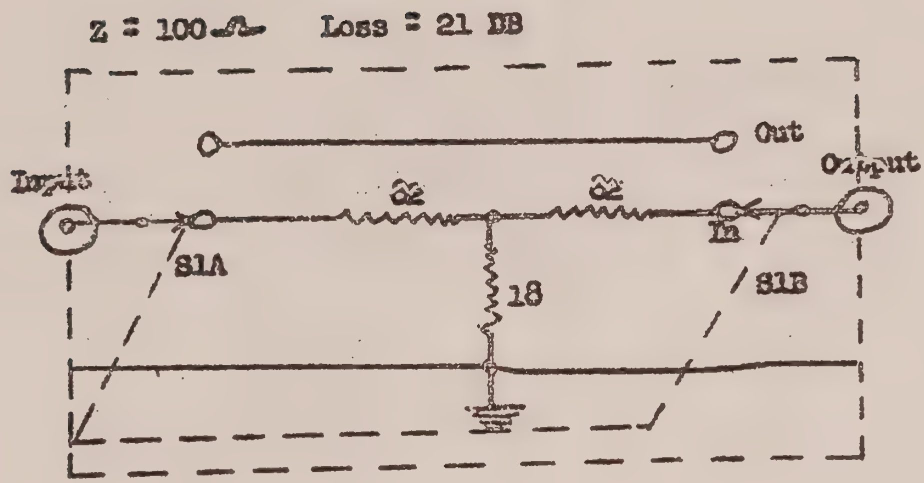


NOTES: See Appendix 2 for other revisions relating to use of the 6DC6 in the 75A-3.

All resistors 10% tol., 1/2 watt.

FIGURE 3

RF Attenuator



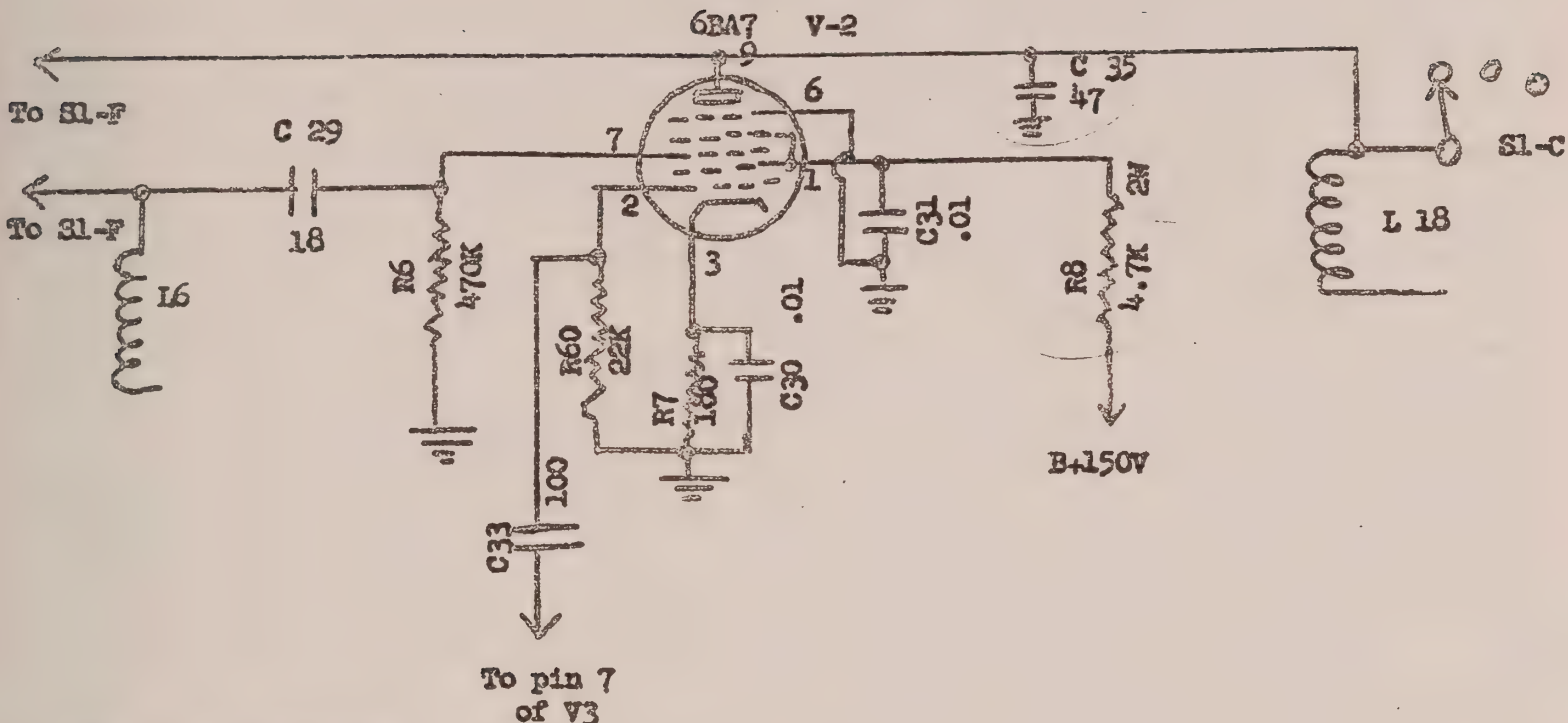
S1   DPDT Toggle Switch
J1
J2

plus photo

FIGURE 4

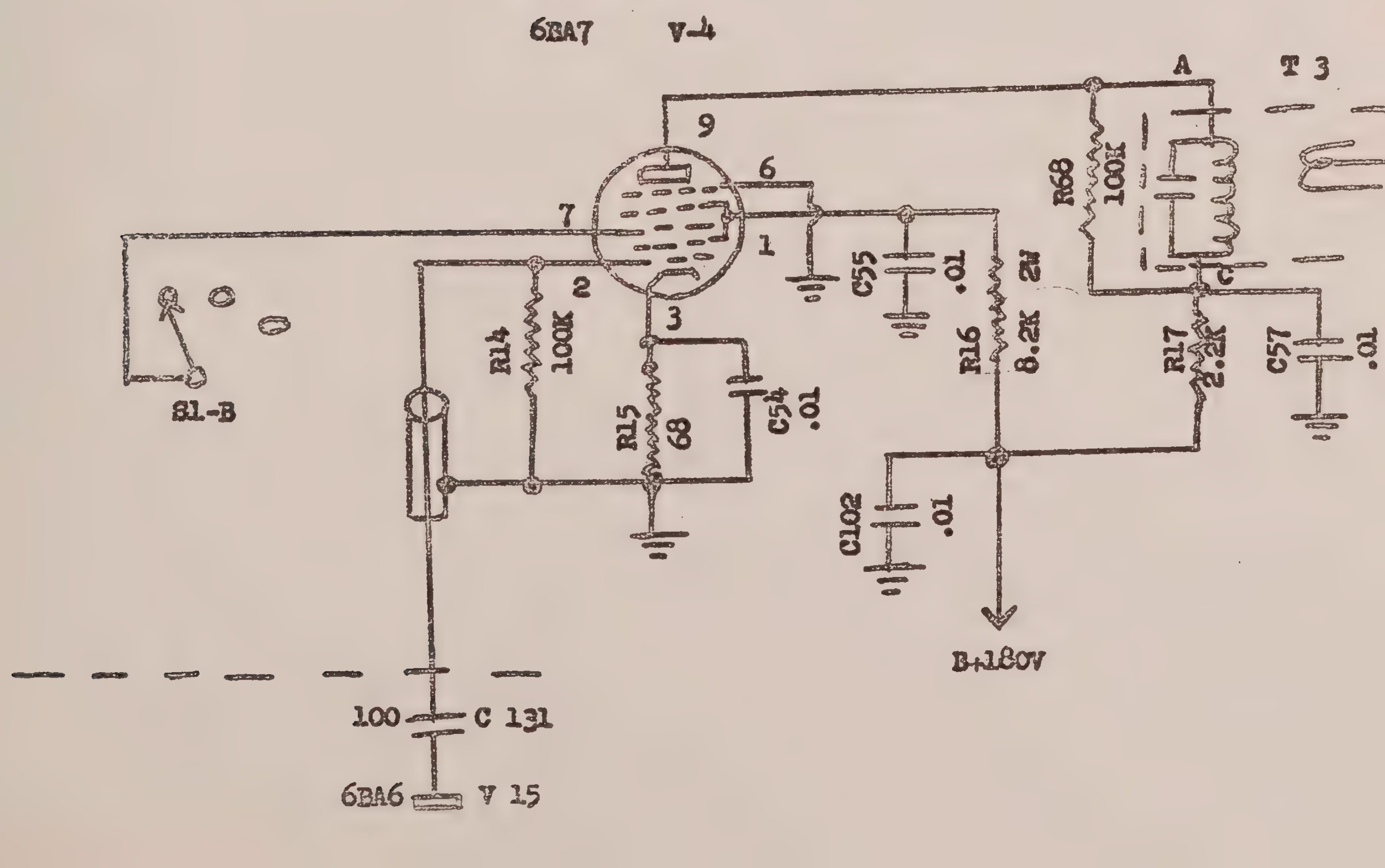
6BA7 MIXERS

First Mixer



TB: All resistors
10% tol., 1/2 watt
unless otherwise noted

SECOND MIXER



MECHANICAL FILTER

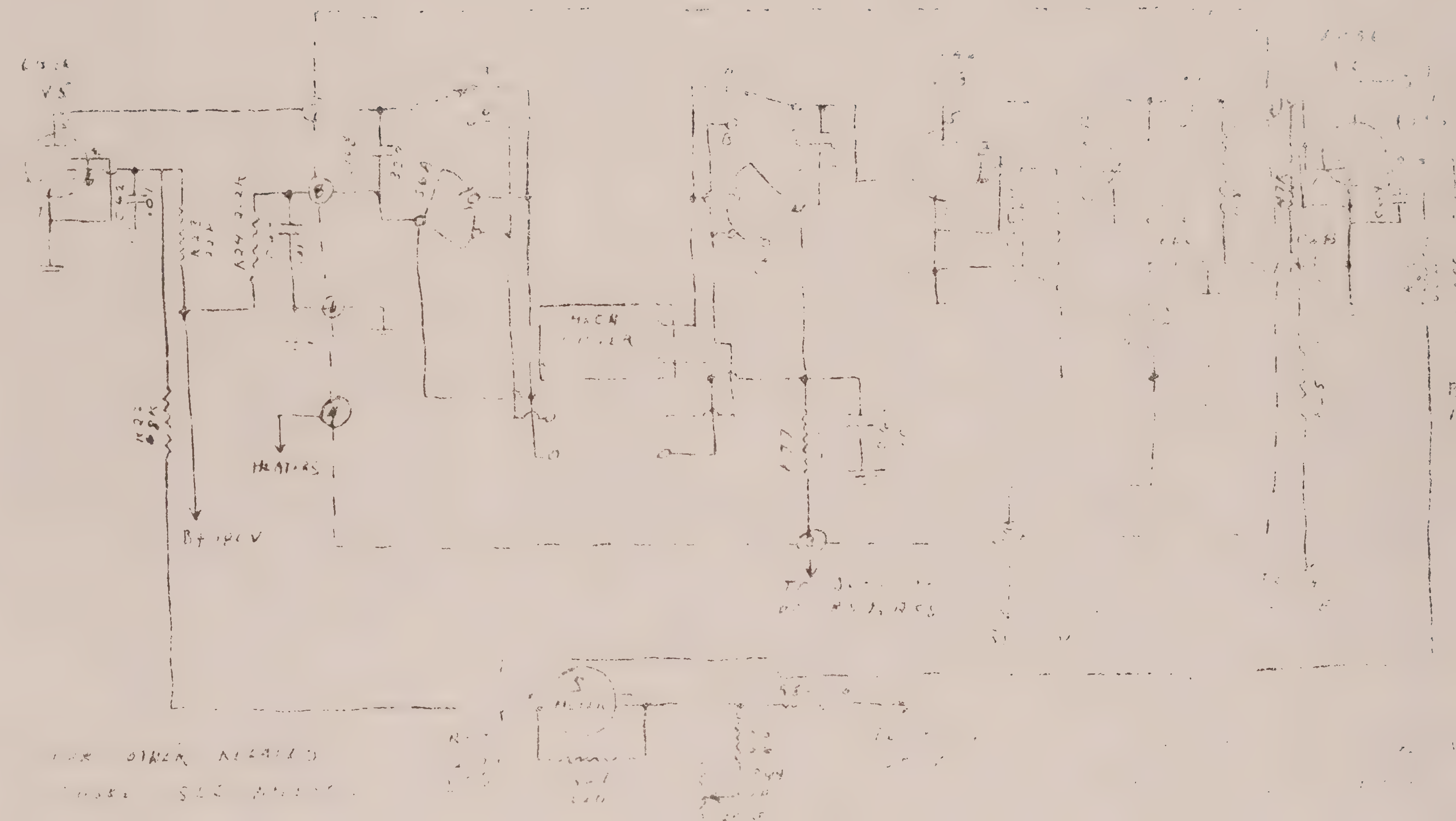
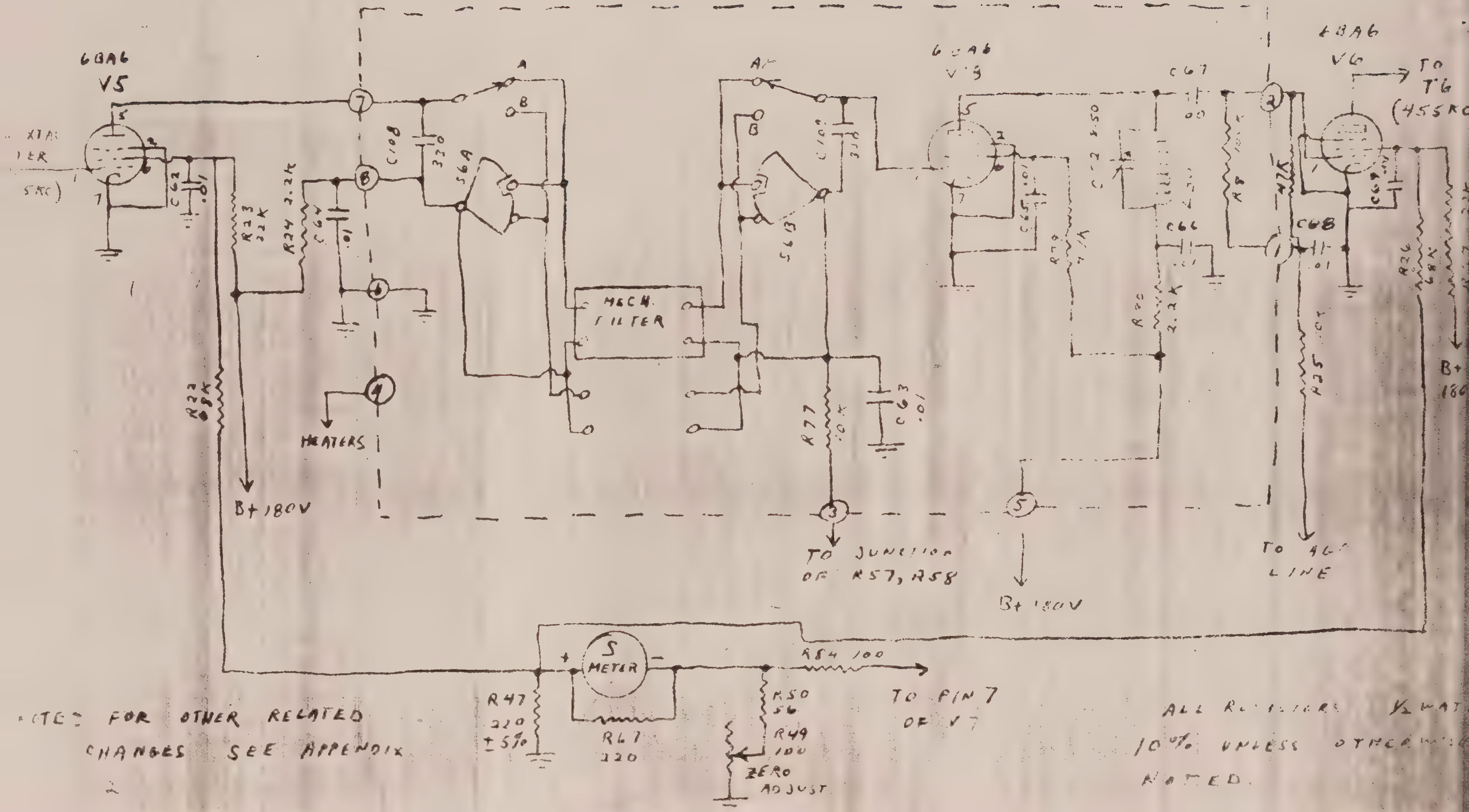


FIG 5

75A3 IF USING 455B SERIES

MECHANICAL FILTER

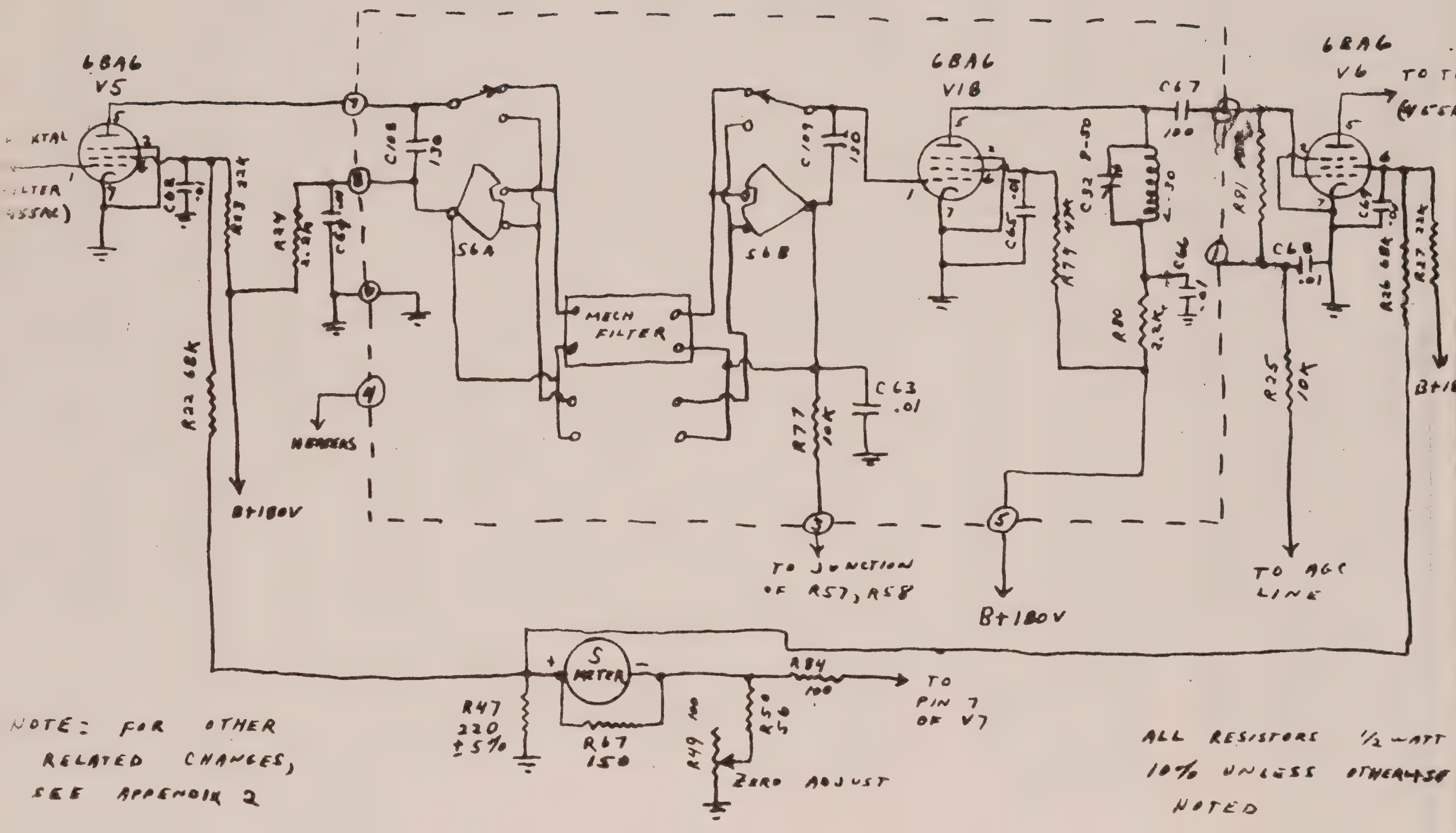


NOTE: FOR OTHER RELATED CHANGES SEE APPENDIX

ALL RESISTORS ½ WATT 10% UNLESS OTHERWISE NOTED.

FIG 6

75A3 IF USING 455 C SERIES
MECHANICAL FILTER



NOTE: FOR OTHER RELATED CHANGES, SEE APPENDIX 2

ALL RESISTORS 1/2 WATT 10% UNLESS OTHERWISE NOTED

75A-2 and 75A-3 VFO ADJUSTMENT

The VFO is calibrated and sealed at the factory and should require adjustment at only widely separated intervals. If the calibration error becomes excessive for operation or beyond the point where the vernier dial corrector (ZERO SET Control) can correct, the following procedure should be followed to make correcting adjustments. WARNING: Do not adjust the VFO unless there is danger that the ZERO SET adjustment will no longer compensate for the error because the adjustment procedure requires breaking the hermetic seal with the possibility of moisture entering the oscillator.

Use the 100 kc/s 8R-1 crystal calibrator if possible or any other accurate calibrator that will furnish fundamental or harmonic frequencies at 1.5 mc/s and 2.5 mc/s. The external calibrator should be coupled into the antenna terminals so that a strong beat note occurs when the BFO is on and the receiver is tuned through the calibrator signal. Allow the receiver to warm up from 1 to 2 hours.

Set the BAND CHANGE switch to the 160 meter band. Tune KILOCYCLE dial to 1.5 mc/s. Set up in accordance with paragraph 6 (a) of OPERATION SECTION to zero beat with calibrator signal.

Rotate KILOCYCLE dial to 2.5 mc/s and exactly tune until zero beat is obtained. Do not readjust BFO or ZERO SET Control. The calibration error is then the number of dial divisions by which the vernier pointer and the dial zero fail to line up. Usually, the error tends to be toward more rotation of the KILOCYCLE dial than the 10 turns that should be required. To correct this error, proceed as follows: remove the shield and tube V18 from the filter FL-1; remove oscillator tube V-14 and with a 3/8 open end wrench remove the hexagonal cap screw from the front of the VFO. Care should be used so that the O-ring seal under this cap is not lost or damaged.

Reinsert tubes V-14 and V-18. Insert VFO adjustment tool into the oscillator and gently rotate it until the tangs of the outer tool engage the lock nut slots. Rotate the outer tool counterclockwise until the lock nut is loosened approximately 1/4 turn or so that the center tool can easily turn the adjusting stud of the trimmer. The above operation will probably disturb the zero beat setting so that the trimmer adjustment stud must be again rotated slightly to restore the zero beat condition.

Rotate the KILOCYCLE dial towards and through dial zero until a total of 1.8 times the dial division error has been counted. Rotate the trimmer adjusting stud until zero beat is restored. Tighten the lock nut securely while maintaining zero beat. The ZERO SET adjustment can now be rotated so that the ZERO SET is set to dial zero.

To check the accuracy of the adjustment retune the KILOCYCLE dial to 1.5 mc/s and check the calibration error. If the adjustments have been done carefully less than 1/2 division dial error will be found. The above procedure can be repeated until satisfactory results are obtained. This endpoint adjustment restores factory accuracy to the intermediate points, also.

After the adjustment procedure is completed, reinsert the cap screw with O-ring in place and tighten securely.

If it is desired to recenter the dial vernier pointer the following additional procedure should be followed. Set the ZERO SET Control to midscale, loosen the two set screws of the VFO dial-shaft coupler and carefully turn the oscillator shaft until zero beat is obtained.

Make final adjustment with the CW-AM-FM switch in AM position and selectivity control in position 4. Adjust the VFO shaft to maximum "S" meter indication and maintain this while the set screws are tightened.

COLLINS RADIO COMPANY

CEDAR RAPIDS, IOWA

SERVICE BULLETIN

EQUIPMENT TYPE 75A-3 and 75A-2A BULLETIN NO. 1 DATE 1-22-54

Subject: Modification to reduce internal noise in the receiver and effectively improve the signal to noise ratio under average operating conditions.

Procedure:

1. Short out the cathode resistor R-48 on I.F. amplifier V-5.

2. Short out the cathode resistor R-78 on I.F. amplifier V-18. This can be done most easily by removing the tube from the socket on the mechanical filter assembly and soldering a small bus jumper from pin 2 to pin 3 on the tube itself.

3. Connect a 100,000 ohm 1/2 watt resistor between pins 1 and 2 on the bottom of the mechanical filter adapter. A suitable resistor for this purpose can be obtained free of charge by contacting the Service Parts Department, Collins Radio Company, Cedar Rapids, Iowa. The part number to specify is 745-1128-00.

Explanation

It has been determined that in early 75A-3 receivers, the tube noise from V-18 was sufficient to over-ride the front-end noise of the receiver. This has been corrected in later sets by grounding the cathodes of these stages and allowing the front-end noise to predominate. These changes increased the overall gain of the set to the point where there may be a slight tendency to oscillate. The 10,000 ohm resistor serves to lower the plate load of V-18 and reduce the overall gain to about its original figure.

As a simple check on operation after these changes have been made, the following test can be made. Removing the first RF amplifier tube with the antenna disconnected should result in a drop of audio noise of at least 6 db. Make this test with the audio volume control set at about mid-scale to preclude any possibility of audio overloading. Set the emission switch to the AM position, the RF gain full on and the frequency dial at about 14.2 mc. Also, peak the antenna trimmer for maximum noise output before removing the RF amplifier tube. This test will give you a pretty good idea of how your set is performing and will tell you whether your receiver gain is correct and whether the receiver noise is coming from the first tube, as it should be.

Address any inquiries concerning this Bulletin to: R. W. Bellew/C. M. Lowder

COLLINS RADIO CO., FIELD SERVICE ENGINEERING DEPT. • 1930 HI-LINE DRIVE • DALLAS, TEXAS

COLLINS RADIO COMPANY

CEDAR RAPIDS, IOWA

SERVICE BULLETIN

EQUIPMENT TYPE 75A-3 BULLETIN NO. 2 DATE 10-27-54

Subject: Suggest modifications of receivers, Serial No. 1300 and over having low-loss mechanical filters.

Procedure: The following changes in the 75A-3 will result in a 2 to 1 improvement in the blocking point of the receiver, and similar improvements in cross modulation characteristics of the receiver.

1. Change V-1 from 6CB6 to 6DC6.

2. Remove R-66 (120 ohms) and C-106 (cathode bypass), tie pins 2 and 7 of RF amplifier to ground.

3. Remove R-65 (1.5 megohm).

4. Change R-7 from 68 ohms, 1/2 watt to 180 ohms, 1/2 watt.

5. Change R-81 from 4.7K, 1/2 watt to 10K 1/2 watt.

6. Change R-67 to 150 ohms, 1/2 watt (meter shunt).

7. Remove AVC from pin 3 of mechanical filter box assembly. Connect pin 3 filter box to junction of R57, R58 (RF gain control and minimum bias resistor).

The above changes apply to sets using the low-loss mechanical filter. Similar revisions will also be made to receivers employing high-loss filters.

R. W. Bellew/C. M. Lowder

COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA

SERVICE BULLETIN

EQUIPMENT TYPE 75A-1 BULLETIN NO. 3 DATE 11-4-47

MUTING COLLINS 75A-1 RECEIVER FOR CW BREAK-IN OPERATION

A method has been worked out wherein the 75A-1 Receiver may be silenced when CW break-in operation is desired. This muting is accomplished by applying a 20 volt positive potential to the cathode (pin #8) of the 6H6 detector limiter tube (V7) when the transmitting key is closed. This 20 volts should drop to zero when the key is up. A one half megohm isolating resistor should be connected to the socket pin #8 of V7 in series with the lead running out to the plus 20 volts.

One place this muting voltage may be obtained is from the voltage drop across a cathode resistor in the transmitter. The tube in the transmitter whole cathode resistor is used for this purpose should be a tube which is biased to cut off when the transmitter key is open.

It is necessary that a common ground connection be used between receiver chassis and transmitter chassis.

This voltage may also be obtained from a B battery of a low voltage power supply, and its application to pin #8 of V7 in the receiver may be controlled by a relay which in turn is operated by the transmitter keying circuit.

In the event cathode keying is used in the transmitter, a resistor may be placed between key and ground, and the voltage drop across this resistor may be used to supply the muting voltage.

You will note that this muting system does not provide protection to the input of the receiver. Protection of the input circuits of the receiver is a separate problem. It is recommended that a small neon bulb be connected between antenna and ground terminals of the receiver for this purpose. In the event a high powered transmitter is used, it is recommended that an antenna ground shorting relay be used in addition to the neon bulb.

COLLINS RADIO COMPANY
CEDAR RAPIDS, IOWA

SERVICE BULLETIN

EQUIPMENT TYPE 75A-1 BULLETIN NO. 4 DATE 12-9-47

SUBJECT: OPERATION OF 75A-1 WITH BREAK-IN SYSTEM

Blocking of the 75A-1 Receiver may occur under certain conditions when using break-in. This blocking effect may show up in several different forms depending upon specific conditions. The following is a description of some of these effects and our recommendations for eliminating the difficulty.

1. The receiver loses its sensitivity for a short period of time, usually only a fraction of a second, after the transmitter is turned off and the R meter swings to full scale and remains there until the receiver recovers. This effect is caused by high RF voltages being applied to the antenna terminals of the receiver when transmitting. This voltage is rectified by the first tube in the receiver, causing the automatic volume control line to charge up. After the control switches are placed in the receive position, this charge will leak off and the receiver will operate in a normal manner. Since the automatic volume control line in the receiver is grounded in CW position, this condition does not occur.

REMEDY: It is recommended that an antenna grounding relay located at the input terminals of the receiver be used when transmitting. It might also be advisable to use a short piece of shielded cable such as coax to connect the receiver to the antenna changeover relay, particularly in the event the same antenna is used both for receiver and transmitter.

2. The receiver loses its sensitivity for an indefinite period but may recover by switching the B + on and off. This is caused by positive transients due to switching appearing on the signal grid. This positive voltage causes secondary emission from this grid and with some tubes this grid may stay positive, thus lowering sensitivity.

REMEDY: The secondary emission characteristics of tubes vary widely, and a different 6SA7 tube may cure this trouble. If not, lowering the grid leak of the 6SA7 tube R5 from 100,000 ohms to 50,000 ohms should definitely eliminate this effect.

SOUPING UP THE 75A-4

We have been hearing much about a modification to the 75A-4 which improves its performance no end. In many cases it is represented as a bona fide Collins modification on which a service bulletin is forthcoming. The rumor has it that removing R46, a 22 K resistor across the 2nd I.F. amplifier tuned circuit, will do wonders with the overall gain. Also that changing the first RF tube for a later and hotter version improves the receiver performance.

Removing R46 increases the IF stage gain up to about 20 db. But this is not good. The 75A-4 is designed to produce AVC action on 1 to 2 microvolts of signal input. Removing R46 causes AVC action to start at about 0.2 microvolts, which is within the receiver noise region, so that AVC action is taking place on receiver or received noise alone. Applying AVC to the RF stage deteriorates the noise figure of that stage. Noise, of course, is the final limiting factor on how weak a signal can be before it is no longer copyable. Thus the weak signal performance is poorer. In other words, performing this mod does increase the signal level, but it increases the noise level even more, so in making your S-meter read higher you have lost some of those weak signals in the noise.

Using hotter RF tubes will also upset the AVC design balance as described above, and also, unless care is taken, noisier tubes might be used, which would further reduce the weak signal performance.

We do not recommend these modifications in the 75A-4 Receiver.

Figure 4—Details of the front panel lettering.

and panel and slide the PCB into the bottom rails of the enclosure from the rear until the front of the PCB touches the inside of the front panel. Mark the mounting hole location on the bottom of the enclosure and drill a 5/32 inch diameter hole. Scrape away any paint or anodizing around the inside of this hole to ensure a good electrical connection between the enclosure and the PCB. Attach the spacer on the bottom center of the completed PCB with a 4-40 × 3/16 inch screw with internal lockwasher and slide it into the enclosure. Guide the controls through the front panel cutouts and insert the panel screws. Be very careful not to over tighten the front and rear panel screws as the aluminum holes are easily stripped. After adjusting R19 in the next section, slide in the top panel, rear bezel, and rear panel and install the four rubber feet on the bottom. Complete the assembly by securing the PCB mounted spacer with a 4-40 × 3/16 inch screw with internal lockwasher from the enclosure bottom.

Setup and Operation

The following instructions are FT-817 specific. For other radios, check the manual for the appropriate control function. FT-817 menu 46 (SSB MIC) should initially be set to the default value of 50. Plug one end of a standard 1 to 3 foot CAT-5 patch cable into MIC OUT jack J2 and the other end into the FT-817 microphone jack. Plug the MH-31 microphone into MIC IN jack J1. (Please note that the VocalMaster is designed to work only with the standard MH-31 microphone. The optional DTMF microphone is not compatible.) Connect a dummy load to the radio, and monitor the transmitted signal on a second rig using headphones. It is very important to monitor your transmitted audio until you have adjusted R19 and are familiar with the operation of the VocalMaster, as improper settings may produce a noisy or distorted signal.

While monitoring your transmitted signal, adjust the controls as follows: TIME CONSTANT to SLOW, NOISE GATE to 10, COMP RATIO to 10, and LIMIT THRESHOLD to 0. At these settings you should hear distortion in the transmitted signal. Adjust R19 to illuminate the red LED on these audio peaks.

The LED output level meter is always active when the bypass switch is in the IN position. This feature allows you to adjust the controls without transmitting (ie, PTT is off). Initially, set the time constant to SLOW, NOISE GATE to 10, COMP RATIO to 1, and LIMIT THRESHOLD to 0. Speak into the microphone with the processor IN and note that two or three green LEDs illuminate. Continue speaking and slowly turn COMP RATIO clockwise until the red LED turns on. A high compression ratio coupled with a low limiting threshold will yield a high output level, which could overload the radio's audio input. These settings will also raise the background noise level and could introduce audible distortion and "breathing or pumping" effects. Reduce the output level by lowering the compression ratio and/or lowering the limiting threshold. Turn LIMIT THRESHOLD clockwise and notice that the output level diminishes. With the compression ratio set to 2:1, a 6 dB change of the input signal level in the compression region causes a 3 dB change in the output level. Likewise, at 10:1 compression, a 10 dB change of the input signal level in the compression region causes a 1 dB change in the output level. Holding the microphone closer to your mouth reduces ambient room noise and gives the audio more presence. If you speak softly or hold the microphone farther away, access FT-817 Menu 46 for further SSB microphone gain adjustments.

The controls are somewhat interactive so experiment with the settings to hear how they affect the audio. Table-1 lists initial positions, general parameters at various settings, and the optimum settings for my operating conditions.

The compression ratio will keep the output steady over a wide range of microphone to speaker distance, and the noise gate will reduce background noises. Signals above the limiting threshold are limited at a compression ratio of 15:1 to eliminate overloads. A graph of the Input/Output Characteristics is shown in Figure 1, and two audio WAV files (*VocalMaster-Quiet.wav* and *VocalMaster-Noisy.wav*) are posted on the ARRL Web site (**www.arrl.org/files/qst-binaries/Baker0106.zip**) to let you hear the sound of a VocalMastered SSB signal in a quiet and noisy environment.

Conclusion

I am delighted to report that all of the design goals have been met. The aluminum enclosure is smaller than my FT-817[11] and provides good shielding. All components mount on a printed circuit board, including the microphone connectors. An LED output level meter provides visual feedback, and a built-in signal generator simplifies antenna tuning. As an added bonus, the Yaesu FT-857 and FT-897 also use the MH-31 microphone, so the processor can be used on all three rigs. On-the-air reports with the FT-817 have been very favorable with an average 6 dB increase in signal strength. The VocalMaster will enhance your SSB signal and you will be proud to place this eye-catching accessory next to your rig. Once you have rounded up all of the parts this project can be completed in a weekend, so heat up your soldering iron and give your QRP station some pizzazz!

Notes

[1]M. Gonsior, W6FR, "MikeMaster—A Microphone Preamplifier with Noise Gating and Compression, *QST*, Mar 1998, pp 33-36; P. Salas, AD5X, "FT-817 Speech Compressor," **www.eham.net/articles/2627**; J. Orman, "Q&D Compressor 2," **www.muzique.com/ssm2166.htm**.

[2]Analog Devices, "Microphone Preamplifier with Noise Gating and Compression, SSM-2166 Data Sheet," **www.analog.com/UploadedFiles/Data_Sheets/83095497SSM2166_b_.pdf**.

[3]LM123 LM224 LM324 LM2902 Low Power Quad Operational Amplifiers, National Semiconductor, **www.national.com/ds/LM/LM124.pdf**.

[4]LM3915 Dot Bar Display Driver, National Semiconductor, **www.national.com/ds/LM/LM3915.pdf**.

[5]K. Theurich, DGØZB, "Dynamic Compressor for the FT-817," *FunkAmateur*, Apr 2002, p 389.

[6]Steve Daniels of Small Bear Electronics has indicated that he has 200 of the SSM2166P chips with more available on the wholesale market; **www.smallbearelec.com/Ordering/ICsCompExp.htm**.

[7]ExpressPCB, printed circuit boards and free software, **www.expresspcb.com**. Contact the author to determine the availability of prefabricated PC boards.

[8]S Ulbing, N4UAU, "Surface Mount Technology—You Can Work With It!," *QST*; Part 1, Apr 1999, pp 33-39; Part 2, May 1999, pp 48-50; Part 3, Jun 1999, pp 34-36; Part 4, Jul 1999, pp 38-41.

[9]Dry Transfer Decals, Woodland Scenes, #WOODT507.

[10]dBu is a means of expressing voltage, referenced to 0.775 V, regardless of impedance. One mW of power is dissipated if 0.775 V is applied to a 600 Ω load, so for a load impedance of 600 Ω, 0 dBu = 0 dBm.

[11]The VocalMaster was designed with the FT-817 in mind, but should work with any transceiver that uses a 600 Ω mic at the appropriate level and has 5 V available.

Allen Baker, KG4JJH, received his license in 2000, after a lifelong dream of becoming a ham. He holds a BS in Industrial Engineering from Tennessee Technological University and works as an Instrumentation & Controls Engineer for the company that operates the US Department of Energy weapons plant in Oak Ridge, Tennessee. Allen is active on SSB and the digital modes, enjoys the challenge of working QRP and loves to experiment with antennas and radio gear. He can be reached at 211 Brochardt Blvd, Knoxville, TN 37934 or **kg4jjh@arrl.net**.

Vintage Product Review—The Collins 75A-4 Receiver

Stu Cohen, N1SC

Being asked to do a product review for the venerable Collins 75A-4 receiver is like asking a civil engineer to do an evaluation of the design of the Empire State Building; they both elicit the kind of response and respect normally reserved for benchmark milestones that rarely appear. A review of so lofty a standard can be a humbling experience, and, indeed, many consider the 75A-4 to be the best tube-type amateur-band receiver ever built.

It was, in fact, ahead of its time in many ways. Single sideband (SSB) was a relatively new communications mode in 1954, and the 'A-4 was the first receiver designed to make SSB easy to tune and a pleasure to operate, while not ignoring the AM, CW and RTTY modes. Although it was produced in relatively few numbers (less than 6000), the 75A-4 left its mark on amateur receiver design for years to come. Many manufacturers emulated its design. The Collins product was coveted then, and is still coveted by hams today. Unfortunately, its price tag ($595 in 1955 dollars; later raised to $695 in 1958), kept it out of the reach of all but the most affluent or dedicated of hams.

A Bit of History

The 75A-4 was the final iteration of a receiver design series started by the Collins Radio Company of Cedar Rapids, Iowa in 1947. Although the first 75A appeared that year (in prototype form), it wasn't until 1948 that the 75A-1 appeared on dealers' shelves. The series shared a unique design for its day: Crystal-controlled converters operating into a tracking IF amplifier and mixer and fed by a linear, low frequency, permeability-tuned variable oscillator (PTO). The architecture and PTO ensured equal stability and linear calibration on all bands and the tuned IF amplifier ensured optimum image response and gain across the mixer's output. The hermetically sealed linear PTO was not easy to manufacture, but it would remain a Collins trademark for years to come.

The 75A-1 receiver was quickly followed (in 1950) by the 75A-2. It boasted a new, redesigned dial with circuitry changes that took advantage of miniature tubes (these had low interelectrode capacity and high transconductance, and performed measurably better at high frequencies than the earlier receiver's octal tubes). 1952 saw the introduction of the 75A-3—its claim to fame was the Collins mechanical filter—a marvel of electromechanical design that is still manufactured today (more about that later).

The 75A-4 finally appeared in 1955, and effectively "tied the ribbons" on the series. The receiver boasted, in addition to the standard 75A features, one 3.1 kHz mechanical filter, with an option for two more (switchable from the front panel), detectors for both AM and SSB/CW (including a new SSB product detector), a completely redesigned AGC circuit incorporating time constants specifically tailored to SSB and CW, improved circuit design exploiting the then current best miniature tubes available, a Q multiplier giving up to 40 dB of rejection at the IF and, finally, a novel new tuning technique called *passband tuning*. Later versions of the 'A-4 also incorporated a special 4:1 vernier tuning knob and gear mechanism that could be retrofitted to earlier models of the receiver. Interestingly, the RF amplifier had 17 dB less gain than earlier versions in order to cope with strong signal overload and better adjust the receiver's dynamic range in the presence of strong signals.

Bottom Line

The Collins 75A-4 was considered by many the amateur receiver benchmark in 1954. It is not quite a contender based on today's toughest standards, but a joy to use none the less.

What Makes It Work?

A block diagram of the receiver is shown in Figure 1. The 75A-4 is a dual conversion design on all bands except 160 meters, where it is single conversion—direct into the tunable IF. The first converter circuit (after the RF stage) employs a crystal-controlled oscillator (separate crystals for each band are selected by the main bandswitch) that, with the first mixer, converts the incoming RF signal to a variable IF of 1500 to 2500 kHz. This first IF is tracked, tuned and linked to the PTO (a Collins type 70E-24), through a complex system of gears, cams and powdered-iron slugs as shown in Figure 2. The first variable IF is mixed with the PTO output (1955 kHz to 2955 kHz) in a second mixer to produce a second, fixed-frequency IF of 455 kHz. Amazingly, all of the variably tuned stages, including the RF stage, the first mixer, the variable first IF system and the PTO, are all tuned by the main tuning dial, which is directly coupled to the PTO shaft. All coupling is accomplished through the previously discussed system of gears, cams, slugs and belts. In fact, with the cover removed from its IF section, the 75A-4 is a joy to watch as it is being tuned. One wonders how the designers got all this "Rube Goldberg" complexity to work properly, but they did.

The RF stage, a type 6DC6 pentode, was specially chosen for its low intermodulation distortion (IMD) characteristics. It was probably the best tube choice for its day, although better choices became available later on, and some later third-party modi-

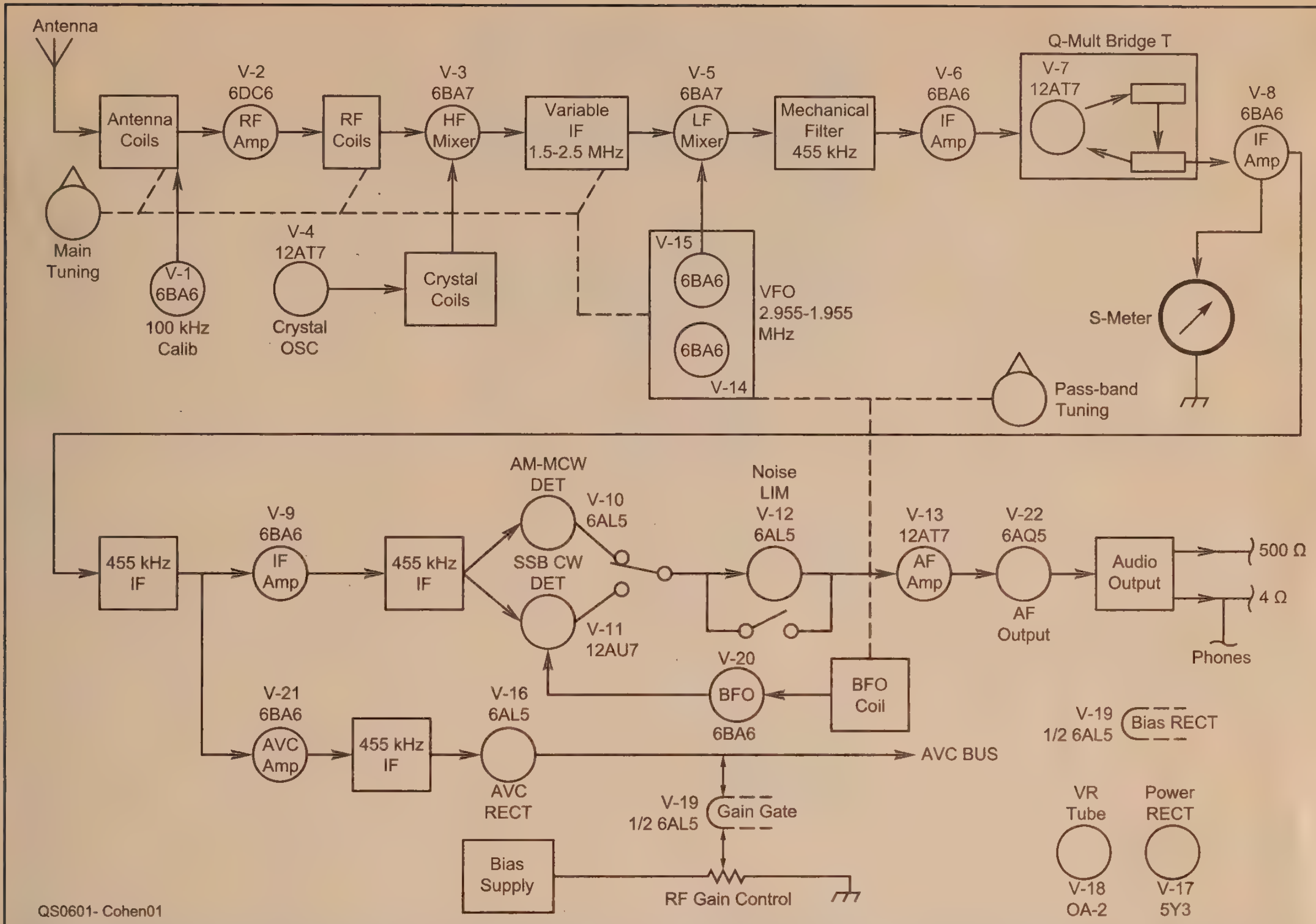


Figure 1—Block diagram of the Collins 75A-4 receiver. Note the tracked, variably tuned stages that are linked to the main tuning (PTO) dial. From *QST*, April 1955, page 41.

fications reflect that replacement choice. It is probably worthwhile to mention here that this 75A-4 receiver (S/N 1777) is completely "stock" and original; no circuit modifications have been made to it.

The second IF amplifier employs the famous Collins mechanical filter to shape its band-pass characteristic. This filter contains multiple nickel-alloy discs that are driven by *magnetostriction* in order to convert electrical current into mechanical vibration and back again. Without going into too much detail, suffice it to say that an input coil within the filter, resonant at the IF of 455 kHz, causes a close-coupled nickel wire to vibrate at this rate, synchronizing its mechanical motion to a series of discs contained within the filter. The last filter disc is "read" by another nickel wire coupled to an output coil, which translates the mechanical motion back into an output current.

What all of this fancy magnetostriction conversion does is to produce a selectivity curve with an almost ideal flat top (devoid of ripple) and almost straight sides. Crystal filters, by comparison, can produce as good a skirt response, but usually at the expense of ripple in their passband. Interestingly, mechanical filters are still produced by Rockwell-Collins, and they find wide use in military receivers and avionics equipment. They are currently offered by at least one major amateur equipment manufacturer (Yaesu) as an option for some of their HF transceivers.

The 75A-4 receiver was normally outfitted with one 3.1 kHz mechanical filter. The receiver could accommodate two additional filters; these were left as options for their owners. This particular receiver has the stock Collins 3.1 kHz mechanical filter and, additionally, a 500 Hz CW filter and a 6 kHz AM filter. The additional filters were manufactured and supplied by Dave Curry, WD4PLI, and they function as well as the originals.[1]

A Q multiplier follows, and it is used as a regenerative IF rejection filter, providing up to 40 dB of rejection for any heterodyne within the IF passband. Detectors consist of a standard diode detector for AM followed by a noise limiter and include what is probably one of the first examples of a product detector to be found in a commercial amateur receiver. This SSB detector is actually a mixer, taking the BFO signal and mixing it with the output of the 455 kHz second IF amplifier. The result is a low distortion audio signal with linearity that improves greatly on the use of a diode detector for SSB. Ample and stable BFO injection levels coupled with superior frequency stability, the use of a well-designed product detector, attention to proper AGC time constants (both attack and delay times) and superior, low distortion audio result in the 75A-4's excellence as an SSB receiver. Anyone who has ever tuned a 75A-4 across a SSB signal knows what I mean—it is simply a pleasure to copy SSB and CW on a 75A-4.

Earlier, I mentioned Collins' introduction of a novel "new" tuning technique called "passband tuning." In what was another first, the 75A-4 saw premier use of passband tuning in an amateur receiver. These days, we take passband tuning for granted; many modern HF transceivers offer it. In 1955, however, it was something very special. It's probably

[1]Curry uses currently manufactured Rockwell-Collins mechanical filters, packaging them in a case almost identical to the original 75A-4 design, with an impedance matching network. They are electrically equal to or better than the original Collins design. He can be contacted at Longwave Products, PO Box 1884, Burbank, CA 91507.

Table 1
Collins 75A-4, serial number 1777

Manufacturer's Specifications	*Measured in the ARRL Lab*
Frequency coverage: Receive, 1.5-2.5, 3.2-4.2, 6.8-7.8, 14-15, 20.8-21.8, 26.5-27.5, 28-30 MHz.	As specified.
Modes of operation: AM, SSB, CW.	As specified.
CW/SSB sensitivity (6 dB S/N, 3 kHz BW): 1.0 µV.	Noise floor (mds), 500 Hz bandwidth: 3.5 MHz –140 dBm 14 MHz –141 dBm.
Blocking dynamic range: Not specified.	Blocking dynamic range, 500 Hz filter: *Spacing:* *50 kHz* *20 kHz* *5 kHz* 3.5 MHz 116 dB 84 dB 74 dB[1] 14 MHz 108 dB 90 dB 72 dB.[1]
Two-tone, third-order IMD dynamic range: Not specified.	Third-order IMD dynamic range: *Spacing:* *50 kHz* *20 kHz* *5 kHz* 3.5 MHz 93 dB 73 dB 59 dB[1] 14 MHz 79 dB 74 dB 62 dB.[1]
Third-order intercept: Not specified.	Third-order intercept: *Spacing:* *50 kHz* *20 kHz* *5 kHz* 3.5 MHz +1 dBm –23 dBm –35 dBm 14 MHz –17 dBm –24 dBm –27 dBm.
Second-order intercept point: Not specified.	+64 dBm.
Audio output: 0.75 W at 10% THD into 4 Ω.	1.7 W at 10% THD into 4 Ω.
IF/audio response: Not specified.	Range at –6 dB points (bandwidth): CW: 240-819 Hz (579 Hz) USB: 500-3044 Hz (2544 Hz) LSB: 544-2925 Hz (2381 Hz) AM: 111-2993 Hz (2882 Hz).
Power requirements: 105-125 V ac, 85 W.	
Size (HWD): 10.5×17.3×15.5 inches; weight, 35 pounds.	

Third-order intercept points were determined using an S5 reference.
[1]Filter blow-by was observed on these measurements.

an understatement to say that the ability to move the IF passband with respect to a signal in that passband is a valuable attribute.

The extremely stable BFO is adjusted by a front panel control labeled PASSBAND TUNING. That control shaft is directly coupled to the PTO mount (which is in a gimbaled crib) by a flexible metal belt, such that the PTO drive shaft doesn't move (the dial frequency remains fixed, held by the friction of the dial drag adjustment); only the PTO mount moves. As the BFO frequency is shifted (through a range of about ±2000 Hz, centered around 455 kHz), the PTO frequency is altered by the same amount. The result is that the fixed IF passband is shifted with respect to the signal and the signal can thus be shifted across the IF passband. A little test will reveal that the 75A-4's PTO-BFO coupling is extremely precise. The receiver's 100 kHz calibrate signal is set to zero beat with the BFO signal. The PASSBAND TUNING control is then moved through its range. On a properly adjusted 75A-4, the BFO will remain in perfect zero beat as the PASSBAND TUNING control is moved from one end to the other! The coupling between BFO and PTO is so good that the BFO appears to be phase locked to the calibrate signal. This is an amazing achievement. It is a testament to the receiver's designers that they were able to do this mechanically, rather than electrically, and thus avoid the non-linear phase issues that could be associated with an electrical solution. A view of the PTO-BFO coupling mechanism can be seen in Figure 3.

The 75A-4 operator thus has a commanding arsenal of interference fighting aids at his or her side. There are three switchable mechanical filters with very steep skirts and almost textbook-like passband characteristics, a very effective passband tuning control to dump an interfering signal off the passband edge and, finally, a Q multiplier to reject heterodynes in the IF passband by up to 40 dB. In addition, a very effective noise limiter, which works in all modes, is also available by a front panel switch.

Dial calibration is another area in which the 'A-4 excels. A switchable 100 kHz crystal calibrator is included to calibrate the PTO. After calibration, the linear PTO can be read to a marked accuracy of 1 kHz and interpolated to less than half that figure. The edge-to-edge linearity of the PTO is better than the dial index width and, in any case, within 150 Hz. Remember, we're back in 1955

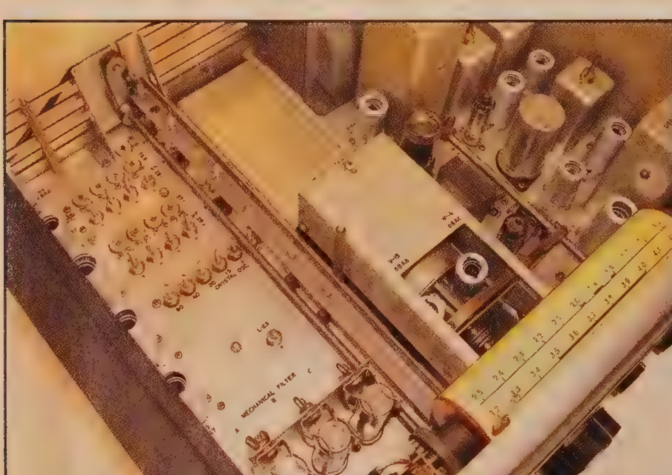


Figure 2—Inside view of the 75A-4 with the cover over the slug rack removed. The bar on the left side of the receiver moves the slugs in the RF and first IF up and down as the PTO is tuned.

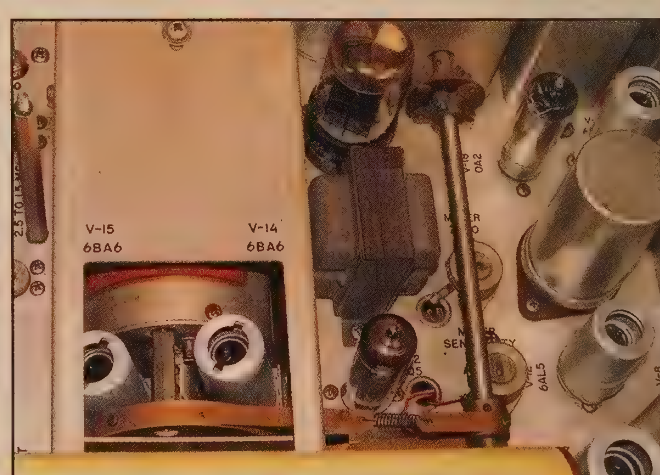


Figure 3—Close-up of the BFO-PTO coupling mechanism with the PTO shifted to full USB position. This forms the basis for the passband tuning system.

here—and this is an *analog* dial. Electronic frequency counters were not in wide use (other than in laboratories) and direct dial readout to 500 Hz was almost unheard of then. Lucky indeed was the operator who could maintain a sked on 14,133 kHz, put the receiver dial on 14,133, turn the receiver on, and have the other op be there. Of course, unless the other op was using similar Collins equipment, the chances are that he wouldn't be exactly there! A close-up of the 75A-4's analog dial is shown in Figure 4.

Operation

Although the size of this radio is certainly not commensurate with today's equipment, it's not ungainly for a 22-tube receiver. Collins recognized that size and weight were becoming an issue with "modern" hams and the 75A-4's cabinet was made noticeably smaller than its earlier brothers in the series. The earlier 75As were designed to be easily rack-mountable, so their panels and cabinets were designed to accommodate standard size 19 inch rack. The 75A-4 cabinet, however, was designed as a part of the front panel; it is noticeably more svelte than earlier models. Indeed, the 75A-4 weighs 15 pounds less than a 75A-3 and Collins managed to shave almost 4 inches off the width of the receiver and 2 inches off the height, compared to its ancestors. Interesting, though, is that the 75A-4 is 2¼ inches deeper than its earlier siblings.

Regardless of its size, it's obvious during operation that this is a "real" radio—the controls are large and easy to read—there are no menus, miniature switches or tiny knobs here. Obvious, too, is the fact that vacuum tubes take a while for their filaments and cathodes to heat—we're easily jaded by *instant-on* communications equipment these days. A good minute passes after ac power is applied before any sounds are heard from this receiver's speaker.

Tuning this receiver is different than tuning a modern radio. The analog tuning knob is connected directly to the PTO—there's no flywheel on a digital shaft encoder here. The tuning is silky, yet it lacks the inertia that a weighted knob would impart. If you've never tuned a Collins amateur receiver, it takes some getting used to. I like the tuning feel—it's directly in touch with the circuit elements that determine frequency in the receiver—a "close to the road" feeling, if you will. There is a dial drag adjustment; this sets the torque level that must be imparted to the tuning knob to get it to move. Properly adjusted, the analog dial has no backlash and is a pleasure to operate. All 75A-4s, save the earliest batch, came with a 4:1 vernier gear reduction tuning knob resulting in a 25 kHz per revolution tuning rate. This is

Figure 4—View of the Collins 75A-4 analog dial. Note that readout can be accomplished to the nearest 1 kHz—14,133 kHz in this example, a formidable achievement for 1955!

a noticeable improvement over the earlier direct-drive knob, and it makes tuning sideband and CW a real delight. The 4:1 knob also has a crank that makes those journeys to the band edges to nab the elusive DX much easier and faster.

The lab MDS measurements reveal that this is a very sensitive receiver, with a noise floor of –140 dBm or about 0.02 μV. The "close-in" numbers, however, suggest that the receiver is not up to present-day standards regarding blocking and IMD. That's not surprising, as the tuned first IF stage has relatively low Q and the tracking was designed mainly to counter images and level the output, not produce a superior roofing filter. Nevertheless, performance under all but extremely crowded band conditions is still excellent and a 75A-4 will hold its own against almost any receiver. Under less crowded band conditions, the performance is superb.

Many agree that signal readability is key to the 75A-4's ability to recover signals that are near the noise floor and the combination of the 'A-4's superb mechanical filters and a very linear signal chain results in signal readability that must be experienced to be believed. In a side-by-side comparison I could copy signals better on the 75A-4 than on an all-solid-state HF transceiver 35 years its junior. The signals were *present* on the transceiver, but they weren't as *readable*. Perhaps this is due to the superior linear phase characteristics through the receiver's signal processing chain. The signal readability is definitely better on this classic.

The 75A-4 really shines on a quiet band. Here, the signal to noise ratio is outstanding, and on 20 meter CW I find myself preferring the 'A-4 to every other receiver I have, including the receiver section of my current production medium priced transceiver. The best way to describe this is to say that the signal copy is less fatiguing on the 75A-4 than on the other receivers. Signals seem to rise out of the noise more cleanly, and tuning the 'A-4 is simply more relaxed. I well realize that this evidence is more anecdotal than scientific, but the static measurements simply do not reveal what is going on with this receiver in a dynamic sense. To paraphrase an old saying: "The proof of the receiving is in the tuning!"

Part of the superb signal handling capability of the 'A-4, I believe, can be attributable to the receiver's gain structure, its clean oscillators and its AGC system. The AGC time constants are very well chosen for both SSB and CW (attack time is 10 ms; release time is100 ms in fast, 1 s in slow) and I found that I never had to "ride gain" with the RF GAIN control when surfing the SSB and CW sub-bands. This is in direct contrast to a 75A-2 receiver I have. There, the AGC system is unable to cope with large signal excursions and manual control of RF gain is always required on CW and SSB. I'm sure that the detector also plays a role. The product detector in the 75A-4 is simply superb on both CW and SSB; the recovered audio is clean and distortion-free, and while the 'A-4 does an excellent job on AM, this receiver was really born to be used on SSB and CW. I do some occasional AM work and I find that reinsertion of the AM carrier and treatment of an AM signal as an SSB signal eliminates a good deal of the selective fading often associated with weak AM signals. The 75A-4 makes that easy to do with its 3.1 kHz mechanical filter—I find that bandwidth to be just about perfect for synchronous AM detection.

If you've concluded from all of this that I like the Collins 75A-4, you're correct. It's quite amazing to be able to compare a 50 year-old receiver to its modern counterparts, and have a favorable result, but there you have it. It's easy to see why this is a coveted receiver—then and now. The 75A-4 was relatively expensive in 1955, but I think it was worth every penny of its price, and if you ever have a chance to use one, do so—I think you'll be pleasantly surprised.

Stu Cohen, N1SC, an ARRL Technical Advisor, was the Technical Editor of QST *from 2002 until semi-retirement to eastern Washington in 2005. He has been an engineering consultant, an assistant chief engineer, and a chief engineer at several commercial and public television stations. Stu was an Engineering Supervisor at ABC-TV, Los Angeles from 1974 through 1993 and received an Emmy from the National Academy of Television Arts and Sciences. First licensed in 1954 (at age 12) as K2IOC, he loves vintage radio and television and has a library devoted to early wireless. Stu chases DX on HF CW and occasionally operates AM on 75 meters. He has a Bachelor of Engineering degree in Electrical Engineering from New York University-College of Engineering and can be reached at* **n1sc@arrl.net**.

A Short History of Radio Transmitters

There were more varieties of early radio transmitters than many of us have heard of. W6BNB, who used most of them, fills us in.

Robert Shrader, W6BNB

Probably the first successful radio transmissions were made by Mahlon Loomis, a Virginia dentist, back in 1865. Loomis inserted a telegraph key between a ¼ λ vertical antenna and ground. The "transmitter" sent radio frequency (RF) radiation from one Virginia hilltop to a similar antenna on another hill 18 miles away. At the bottom of the second antenna was an electromagnetic telegraph sounder connected to ground. He later sent information using similar techniques from a ship to a shore station. The exact mechanism of this system has not been fully explained, although it has been verified and reported on in many venues.[1]

The next radio transmissions, usually considered to be the first, were sent around the turn of the 20th century using "spark" transmitters. The early spark transmitters converted 50 or 60 Hz power line ac to RF ac. Spark transmitters were used by amateurs, by ships and by many land stations.

A third kind of radio transmission was made by "arc converter" transmitters, so named because they converted dc generated power into RF ac power. They also came into use in the first decade of the last century, shortly after spark equipment appeared.

Except for Dr Loomis' system, the others started with very low power outputs but greatly increased their emission strengths as their devices and circuits improved. After about 20 years, old Doc Loomis finally gave up on the communication system he had invented and patented.

Following the previous developments, radio transmitters moved firmly into the vacuum tube and then the solid state era, resulting in equipment that we would now find familiar. The early spark equipment continued to be used, however, especially on ship stations, until long after it was obsolete.

Dr Loomis' Antenna Transmitter Is Interesting

If you were to fly a kite 300 feet high and hold it with the usual string, you will not receive any electrical shock. On the other hand, if you were to use copper wire instead of a string, look out! If the bottom end of a charged kite wire is connected through a key to a steel rod driven into the ground, all of the electrons that were picked up by the wire would discharge down into the earth. The downward discharging of the antenna develops a magnetic field around the antenna. This collapsing magnetic field overly discharges the top of the antenna and another current immediately rushes up the antenna wire to recharge the overly discharged top end. Again it overly charges the top end and another current rushes back down to ground. This is the familiar resonant circuit phenomenon, with the antenna acting like a resonant circuit. What determines the frequency of the resulting alternating current is the length of the antenna wire—the shorter the wire the faster the antenna charges and discharges and the higher the frequency of the RF ac radiated from it.

Old Doc Loomis didn't really understand what he was doing, but at least his two similar antennas did work, when the ungrounded one was grounded by a telegraph key![2] Using a key between the low end of the antenna and ground, every time the key was closed, several cycles of a high level, but rapidly weakening RF signal were developed in the antenna and they radiated a short duration decaying radio

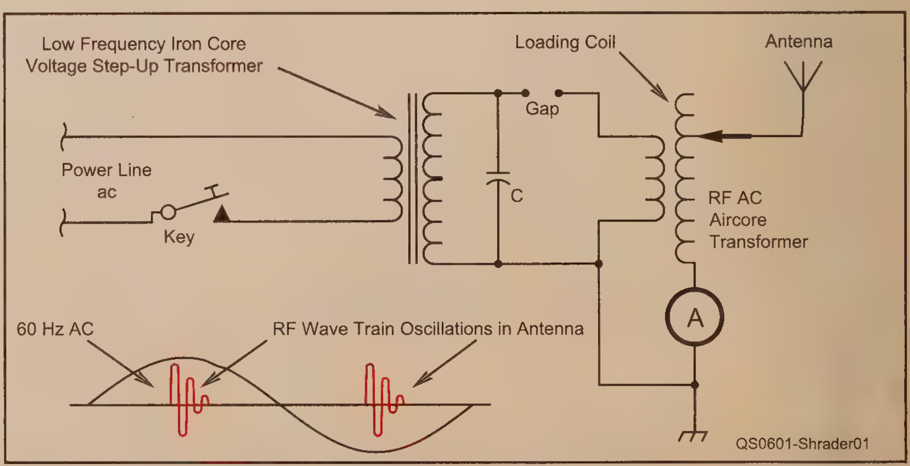


Figure 1—Schematic diagram of a basic spark transmitter. Below, waveforms of ac supply and RF signal.

[1]Notes appear on page 43.

APPENDIX II

Revision of 75A-3 to use 6DC6 or 6BZ6 as RF Amplifier

All resistor tolerances ±10% unless otherwise marked. For sets serial number 1299 and under using the 455B series of mechanical filter:

1. Replace 6CB6 with 6DC6 (V-1).
2. Remove R-66 (120 ohms) and C-106 (Cathode bypass), tie pins 2 and 7 of RF amplifier to ground.
3. Remove R-65 (1.5 megohm). (Some sets may use 1 megohm).
4. Change R-7 from 68 ohms, 1/2 watt to 180 ohms, 1/2 watt.
5. Check to see that pins 2 and 7 of V-18 are grounded. If not, ground them. (This modification has been made on sets with serial numbers higher than 950).
6. Remove AVC from pin 3 of mechanical filter box assembly. Connect pin 3 of filter box to junction of R-57, R-58 (RF gain control and minimum bias resistor).
7. Add R-84 (100 ohms, 1/2 watt) between pin 2 of V-7, and R-50. Move junction of R-67 and negative side of meter to opposite side of R-50.
8. Change R-67 to 220 ohms, 1/2 watt ±5%.
9. Change R-47 to 220 ohms, 1/2 watt ±5%.
10. Change R-50 to 56 ohms, 1/2 watt ±10%.
11. Add 47K, 1/2 watt ±10% between terminals 1 and 2 of mechanical filter box assembly.

For sets serial number 1300 and over using 455C filter:

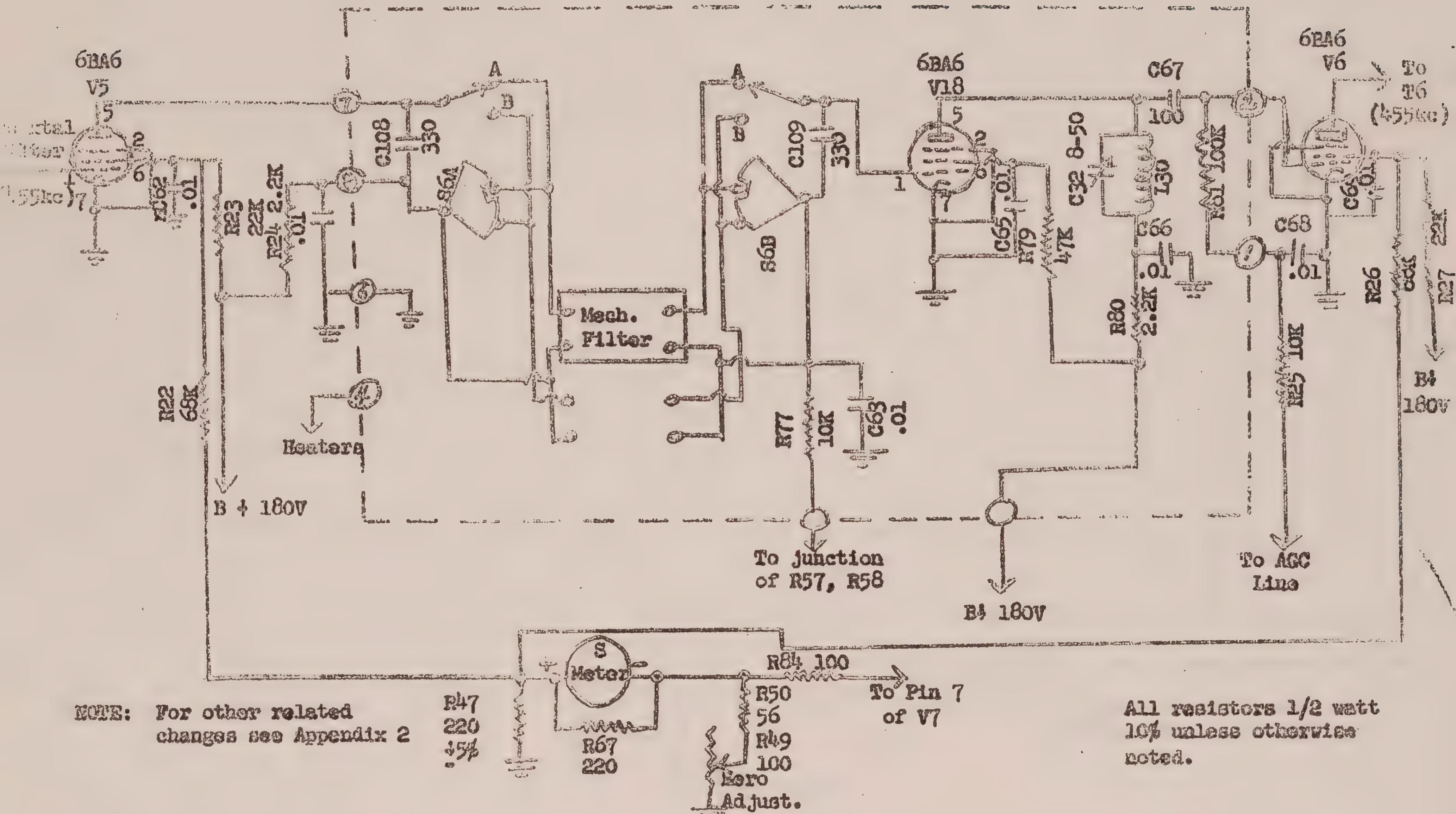
1. Replace 6CB6 with 6DC6 (V-1).
2. Remove R-66 (120 ohms) and C-1 06 (cathode bypass), tie pins 2 and 7 of RF amplifier to ground.
3. Remove R-65 (1.5 megohm).
4. Charge R-7 from 68 ohms, 1/2 watt to 180 ohms, 1/2 watt.
5. Change R-[illegible] from 4.7K, 1/2 watt to 10K, 1/2 watt.

6. Change R-67 to 150 ohms, 1/2 watt (S-meter shunt).

7. Remove AVC from pin 3 of mechanical filter box assembly. Connect pin 3 of filter box to junction of R-57, R-58 (RF gain control and minimum bias resistor).

FIGURE 5

75A-3 IF USING 455B SERIES MECHANICAL FILTER

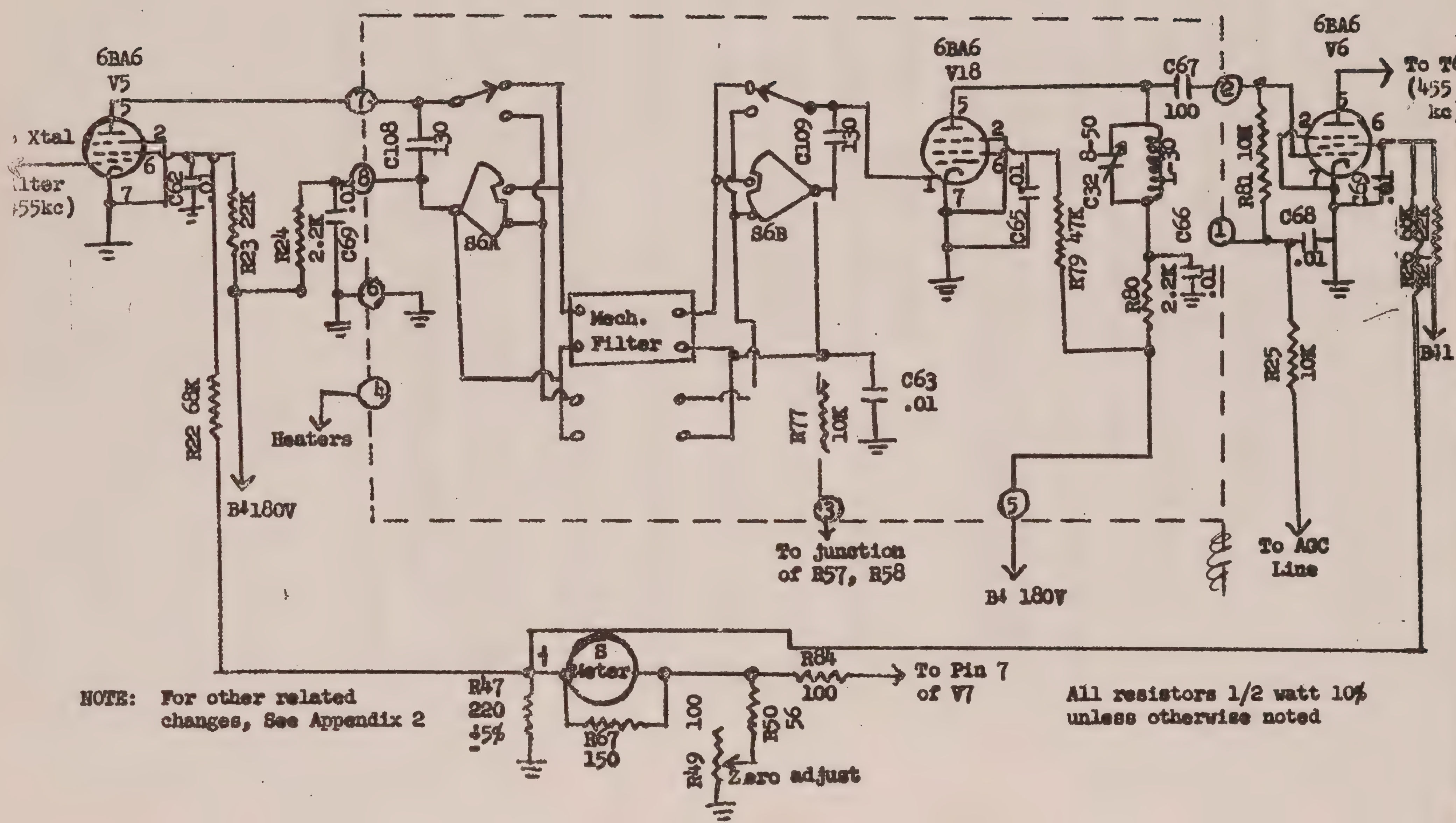


NOTE: For other related changes see Appendix 2

All resistors 1/2 watt 10% unless otherwise noted.

FIGURE 6

75A-3 if using 455C Series Mechanical Filter



NOTE: For other related changes, See Appendix 2

All resistors 1/2 watt 10% unless otherwise noted

APPENDIX II

<u>Revision of 75A-3 to use 6DC6 or 6BZ6 as RF Amplifier</u>

All resistor tolerances ±10% unless otherwise marked. For sets serial number 1299 and under using the 455B series of mechanical filter:

1. Replace 6CB6 with 6DC6 (V-1).
2. Remove R-66 (120 ohms) and C-106 (Cathode bypass), tie pins 2 and 7 of RF amplifier to ground.
3. Remove R-65 (1.5 megohm). (Some sets may use 1 megohm).
4. Change R-7 from 68 ohms, 1/2 watt to 180 ohms, 1/2 watt.
5. Check to see that pins 2 and 7 of V-18 are grounded. If not, ground them. (This modification has been made on sets with serial nos. higher than 950).
6. Remove AVC from pin 3 of mechanical filter box assembly. Connect pin 3 of filter box to junction of R-57, R-58 (RF gain control and minimum bias resistor).
7. Add R-84 (100 ohms, 1/2 watt) between pin 2 of V-7, and R-50. Move junction of R-67 and negative side of meter to opposite sides of P-50.
8. Change R-67 to 220 ohms, 1/2 watt ±5%.
9. Change R-47 to 220 ohms, 1/2 watt ±5%.
10. Change R-50 to 56 ohms, 1/2 watt ±10%.
11. Add 47K, 1/2 watt ±10% between terminals 1 and 2 of mechanical filter box assembly.

For sets serial number 1300 and over using 455C filter:

1. Replace 6CB6 with 6DC6 (V-1).
2. Remove R-66 (120 ohms) and C-106 (cathode bypass), tie pins 2 and 7 of RF amplifier to ground.
3. Remove R-65 (1.5 megohm).
4. Change R-7 from 68 ohms, 1/2 watt to 180 ohms, 1/2 watt.
5. Change R-81 from 4.7K, 1/2 watt to 10K, 1/2 watt.

APPENDIX IV

Revision to Improve Shape of 75A-3 Selectivity Curve.

1. Remove C-110 (top coupling for T-6).

2. Add 82K, 1/2 watt resistor across terminals A and C of T-6.

3. Realign 455 kc. IF using the following procedure:

   a. Connect VTVM DC lead to diode load (junction of R-39 and R-42).

   b. Connect signal generator output to receiver antenna terminals. Set signal generator to some frequency in the 80 meter band. Do not move signal generator frequency during the rest of the 455 kc IF alignment procedure.

   c. Tune receiver to signal frequency.

   d. Adjust signal generator output control for an S-meter reading of S-9 +20 db.

   e. Tune receiver to the S-9 point on the high frequency side of the signal. Record the dial reading.

   f. Tune receiver to the S-9 point on the low frequency side of the dial. Record the reading.

   g. Set the dial half-way between the readings determined in steps e. and f.

   h. Set the fiducial (zero set) accurately to some dial division. During the following adjustments, attenuate the signal generator output to keep the VTVM readings below 5 volts.

   i. Tune dial 3 kc lower than the center frequency (determined in step g). Adjust T-6 (both top and bottom slugs for maximum VTVM readings).

   j. Tune the dial 3 kc above center frequency. Adjust T-3 and T-7 (top and bottom slugs of T-7) for maximum VTVM reading.

   k. Return to center frequency (determined in step g) and tune C-32 for maximum readings.

APPENDIX V

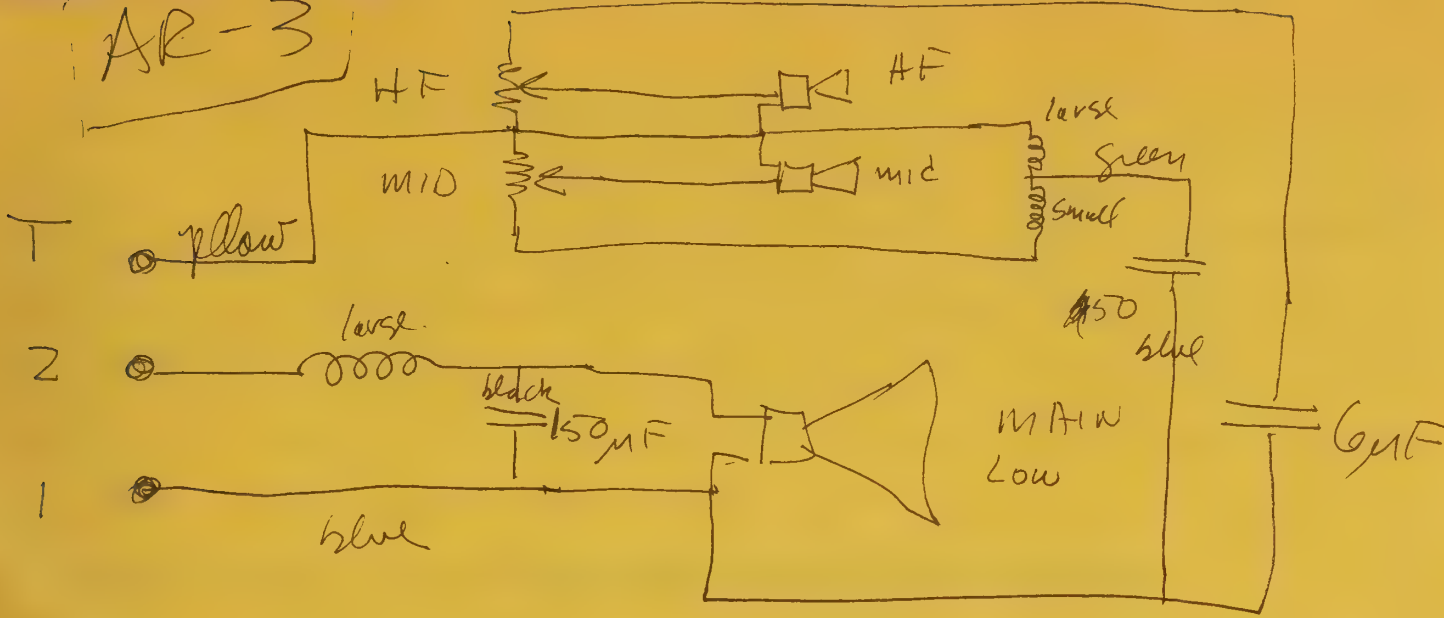
Revision to Improve AVC Noise Immunity.

1. Replace C-82 with .05 mfd 300 volt capacitor.
2. Replace R-35 with 330K 1/2 watt $\pm$10%.
3. Replace C-81 with .2 mfd 200 volt capacitor.
4. Add 180 mmfd mica or ceramic capacitor from pin 2 of V-9 to ground.
5. Replace C-98 with .01 ceramic capacitor.

6. Change R-67 to 150 ohms, 1/2 watt (S-meter shunt).

7. Remove AVC from pin 3 of mechanical filter box assembly. Connect pin 3 of filter box to junction of R-57, R-58 (RF gain control and minimum bias resistor).

AR-3


HF
HF
large
green
MID
mid
small
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yellow
50
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2
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150 μF
MAIN
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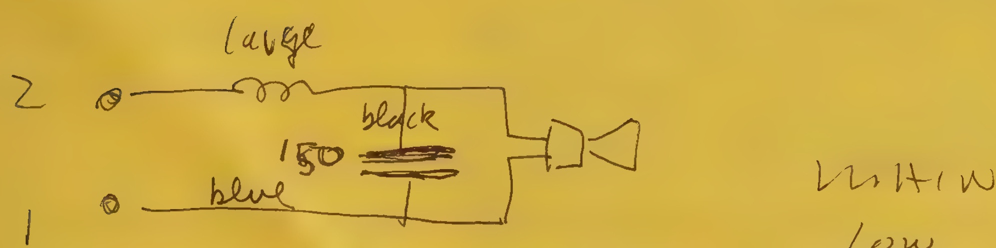
blue


large
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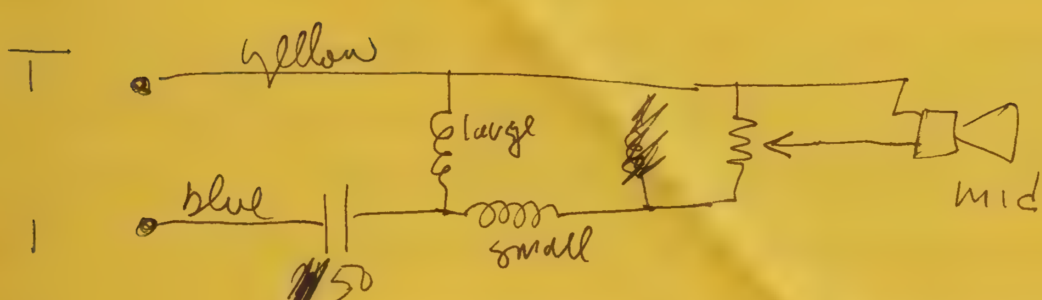
blue
1
MAIN
Low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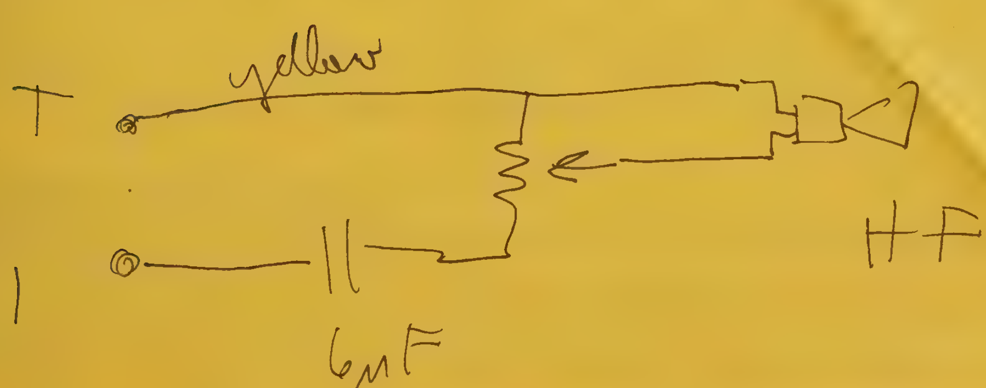

T
yellow
HF
1
6μF

with the transverter at 60 W output, and the 5th, 7th and 9th order products at –38, –44 and –49 dB, respectively. The higher order products (up to 10 kHz away from the operating frequency) were still visible, between 50 and 60 dB down. Checking previous *QST* reviews of VHF transverters and transceivers, I note that 3rd order products vary from –22 dB to –32 dB. At 60 W output, the 144-28HP was certainly not at the head of the class in this respect.

At 40 W, the 3rd order IMD products were better, around –30 dB, and the higher order products about 4 dB better. Perhaps the good on-air reports I had gotten would go away if I ran 60 W, so I repeated the tests with K8ISK who is also using a 60 W DEM transverter. He heard no difference in my signal quality by ear. Then he varied his output from 35 to 60 W. The signal strength may have gone up a few dB but his signal quality was unchanged. He sounded excellent either way.

In discussing the transmitter test results with Steve Kostro at Down East Microwave, we learned that they are in the process of changing to a Toshiba S-AV36 power module with units manufactured in 2006. Steve's testing indicated that the Toshiba module might be more linear, and he offered to install one in the review unit. The results were impressive. The 3rd order products were slightly better at –25 dB, but we measured a marked improvement in the higher order products—the ones that bother your friends up and down the band. The 5th, 7th and 9th order products dropped to –50, –50 and –63 dB respectively, with higher order products all at least 65 dB down and generally in the noise on the spectrum analyzer's display. At 40 W, where I normally run the transverter to drive my amplifier, the 3rd order products were –34 dB, the 5th order products –55 dB and the rest headed into the noise. With the 8877 amplifier loafing at 1500 W output, I expect to have a very clean signal.

(A Few) Downsides

I had two minor complaints. I find the fan that keeps that big heat sink so cool to be rather noisy. Two of the K8GP operators who heard it said I have become old and crotchety—they thought it sounded fine. And that wonderful manual had one shortcoming. Though it has a top and bottom parts layout and component list, the circuit narrative did not appear to correspond with the schematic. A call to DEM revealed that my copy was

A New Look for Product Review

We are always looking for ways to make Product Review, and all of *QST* for that matter, more useful for our readers. Over the years we have received many compliments on the thoroughness and relevance of our ARRL Laboratory test results, a key component of almost every Product Review. We also often receive pleas from readers for help to make the results more meaningful for them—"it's great to see the numbers, but is the result good or bad?"—or "which numbers should I care about, or be willing to pay for?"

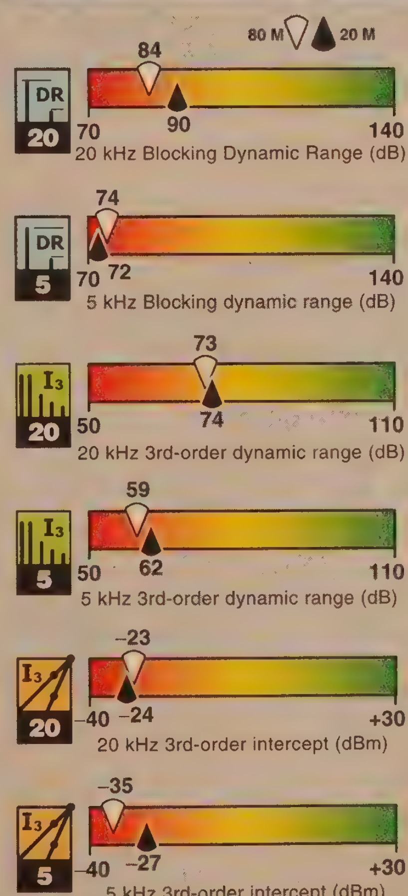
We have made a number of attempts over the years to try to answer such queries by helping readers understand the tests,[1,2] but it was still difficult for some readers to get a feel for how a particular radio's performance compared to that of other radios. The new *Key Measurements Summary* charts represent a way to get that feeling. Our Product Review team has agreed on the subset of data that we feel is the most significant for the decision making process for each equipment type (only *radio* equipment reviews will include this feature) and researched the range of measured values we have seen in recent years of testing. Each graph spans the range that we feel most radios will fall into for each of the key parameters.

It is important to note that for most[3] parameters there is no "good/bad" threshold, and radios can be expected to be anywhere within the range. To avoid that kind of view, we have somewhat arbitrarily divided each range into thirds. The best performing radios are within the green, the middle range are yellow and the lowest performance is shown in red. The boundaries are intentionally blurred because nothing dramatic happens as you cross the boundary. It is also important to note that it is not reasonable to expect lower priced radios to perform as well as higher priced ones.

For this review of a VHF transverter, we selected the following parameters that we thought would make a difference to most buyers:

- Noise figure—a measure of the ability of the receiver portion of the transverter to receive weak si..nals without adding noise.
- Transmit power output—the po..er output varies between differe.. units.
- Transmit intermodulation dist.. tion—this is a measure of h.. good a job the transverter's t..ns-mitter does at eliminating si..ls inside (3rd order) and outsi.. (9th order) the channel that coul.. inter-fere with other band users.

Key Measurements Summary—75A4



PR002

Other types of equipment will ha.. parameters that relate to their key functional areas. The "Vintage Pro...t Review—the Collins 75A-4" article .. page 36 of this issue will give a p.. view of the parameters selected f.. HF receivers. In all cases, each re..ew of a particular type of equipment ..ll include the same parameters, to t..e same scale, so direct compariso.. can be made.

Note that we will continue to l.. all the parameters in the tables—the plots supplement, but do not repla.. the traditional tabular data. We wil.. so be making some subtle changes .. measured parameters starting wi.. HF transceivers. These reflect reade.. ..d technical advisor suggestions an.. will be described as they are introduc.. over the coming months.—*Joel F Hallas, W1ZR, QST Technical Ed..or*

[1]M. Tracy, KC1SX, "*QST* Product R.. views—in Depth, in English," *QS*.., Aug 2004, pp 32-36.

[2]The ARRL Laboratory test procedu..s are described in detail in **www.ar..rg/members-only/prodrev/testpro.. df.**

[3]The notable exceptions are transmi..er spurious and harmonic suppress..on, which is measured against an F.. requirement of 43 dB (for VHF 25 .. and above, 60 dB, with a sloped resp..se in requirement at lower levels), a.. turnaround time. Radios with turn..ound times greater than 35 ms will not ..er-ate properly in many digital mod..

indeed an older version and an updated copy was supplied. The new information now matches the schematic exactly.

Conclusions

DEM is still a leader in the high performance transverter market. I was particularly gratified by the extent to which DEM makes transverter integration a surprisingly easy task. I was also impressed with the careful RF design and the extensive filtering in this unit, which helped to reduce the amount of interference from the many out-of-band signals at my location. Finally, the capability of having enough power to drive most big amplifiers without recourse to an intermediate amplifier is a real step forward. For someone like me going the transverter route, this unit would fit the ticket.

There was no huge E-skip opening while I was checking this transverter such as occurred while I was reviewing a different transverter last year, but conditions during the September VHF contest were better than any in the last four years. Furthermore, while I was giving a talk in the Pacific Northwest on October 1 and 2, the East Coast enjoyed their best tropo opening in the past few years. So I look forward to testing more transverters in the future, as having one around seems to help propagation!

Manufacturer: Down East Microwave, 954 Rte 519, Frenchtown, NJ 08825; tel 908-996-3584; **www.downeastmicrowave.com**. Price: 144-28HP, $589; 144-28, 25 W version, $395; kits also available.

Array Solutions PowerMaster Wattmeter

Reviewed by Mark Wilson, K1RO
Product Review Editor

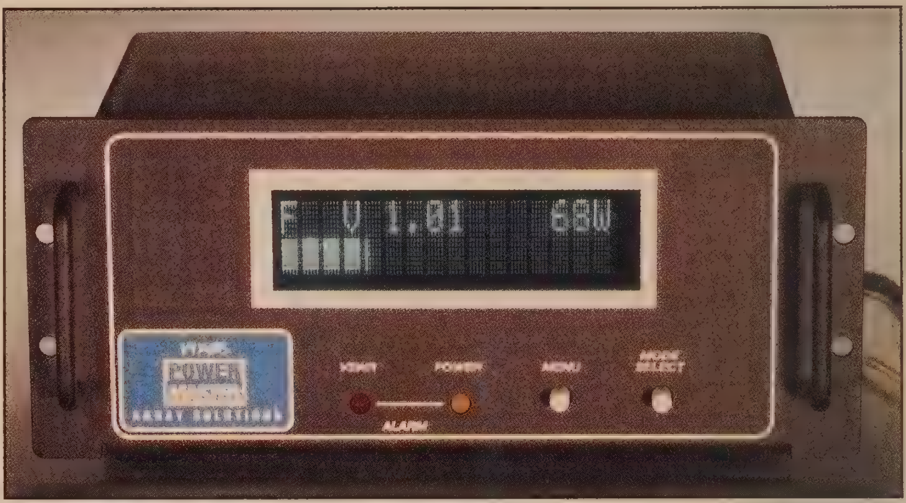
It's been more than 30 years since I put together my first ham station. It was a pretty simple station by today's standards—a Hammarlund HQ-180 receiver, Globe Chief transmitter, TR relay and a hand key. Once I had the basic equipment in hand, the experienced guys in the local radio club strongly suggested that I get an SWR/power meter as soon as possible. "You'll need it to prune your dipole," they said, "and to be sure the 807s in that old transmitter are really working." So I got a wattmeter and I've had at least one in my shack ever since.

Of course Amateur Radio has changed quite a bit. Transceivers and amplifiers and antenna tuners often have power/SWR meters built in. Transceivers don't have to be tuned up any more, and autotuners find the best match. We now have antenna analyzers to prune our antennas, and they give us more useful information about antennas and feed lines than our SWR meters ever did.

Even with the advances in equipment, a standalone wattmeter is still one of the most useful station accessories you can own. It provides independent verification of your transmitter power and SWR and may be more accurate than the built-in meters. Even if your transmitter or amplifier has a built-in power or SWR function, it may be shared with other metering functions and not available full time.

Hooking it Up

The Array Solutions PowerMaster con-



Bottom Line

The Array Solutions PowerMaster is an accurate, expandable RF power meter that blurs the line between station accessory and precision test equipment.

Table 2
Array Solutions PowerMaster Wattmeter, serial number 0143

Frequency Range	1.5-30, 50-54 MHz
Power Range	1-3005 W
Power Requirement	12-15 V dc, 600 mA
PEP Measurement	Active†

Actual Forward Power	*Indicated Peak Power (W)*			
Frequency (MHz)	**2**	**14**	**28**	**50**
5 W CW	5	5	5	4
5 W 50%	5	5	5	5
100 W CW	105	105	105	100
100 W 50%	105	105	105	101
100 W Two-Tone	–	97	–	–
1 kW CW	1010	970	950	‡
1 kW 50%	1040	1020	990	‡
1 kW Two-Tone	–	1005	–	–
SWR Accuracy				
1:1 SWR	1:1	1:1	1:1	1:1
2:1 SWR	2:1	2:1	2:1	2:1
Insertion Loss (dB)	<0.1	<0.1	<0.1	<0.1

Notes
All data agrees with tolerances of both lab instruments and unit under test, see text.
†For PEP monitoring, "Active" indicates that a circuit requiring external power is used.
‡An amplifier for 6 meters was not available at the time of testing.
–Not measured.

75A-4 Rejection Notch Stability

by Ray Osterwald, NØDMS
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One of the most common and most irritating problems with the Collins 75A-4 receiver is drift of the rejection notch alignment. The receiver maintenance procedure provides for a deep, sharp notch with at least 70 dB rejection, but after only a few hours of use the notch becomes wide and shallow. I've seen some come to rest with as little as 30 dB rejection. If this is a symptom in your rig, read on!

Figure 1 is the schematic diagram of the rejection notch circuit in the 'A4. The Bridge-T filter shown inside the dotted box is the plate load for the second half of V7, a regenerative triode IF amplifier. The first half of the tube acts as a cathode follower, so that changes in loading with various settings of the notch frequency control don't "pull" the preceding amplifier stage. Normally, a Bridge-T filter isn't sharp enough for good rejection characteristics when used above 100 Kc. The designer of the 75A-4, Gene Senti, increased the filter's Q by a factor of several hundred by using the filter in the plate circuit. Regeneration makes the notch filter effective at 455 Kc, at least for a while!

The filter center frequency is controlled by the parallel resonant combination of L26 (about 237 uH) and the

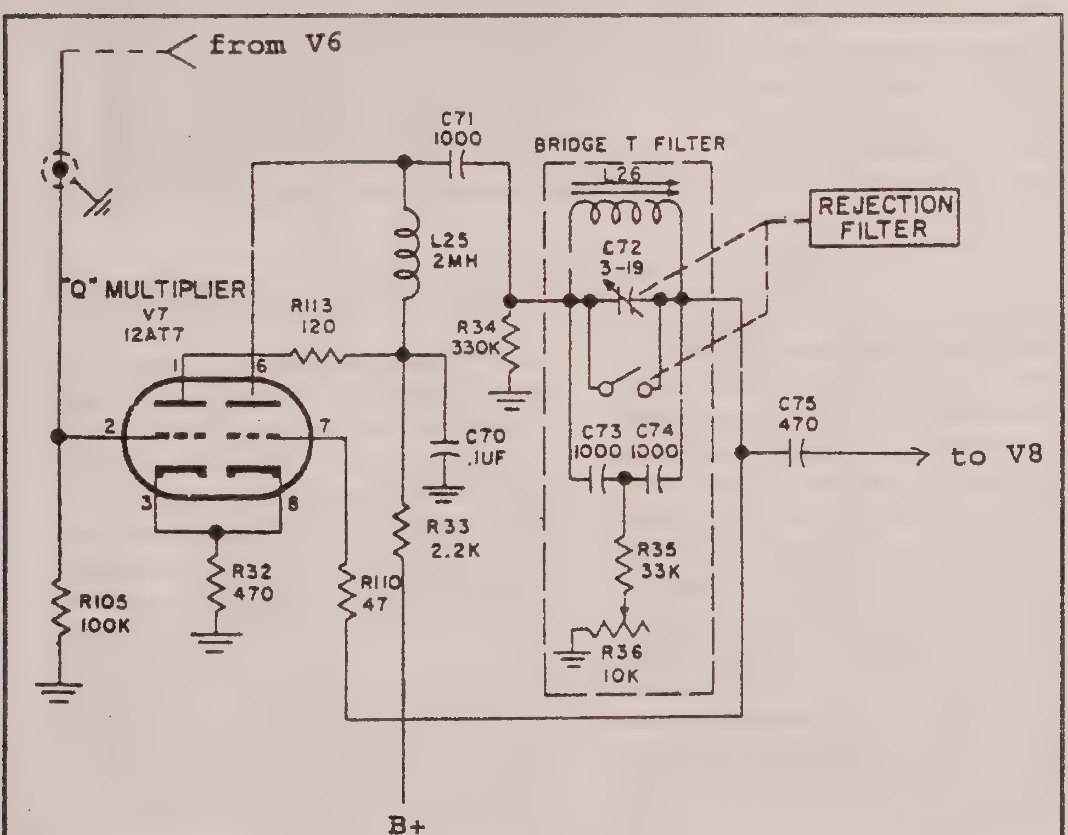

Figure 1. P/O 75A-4 schematic diagram.

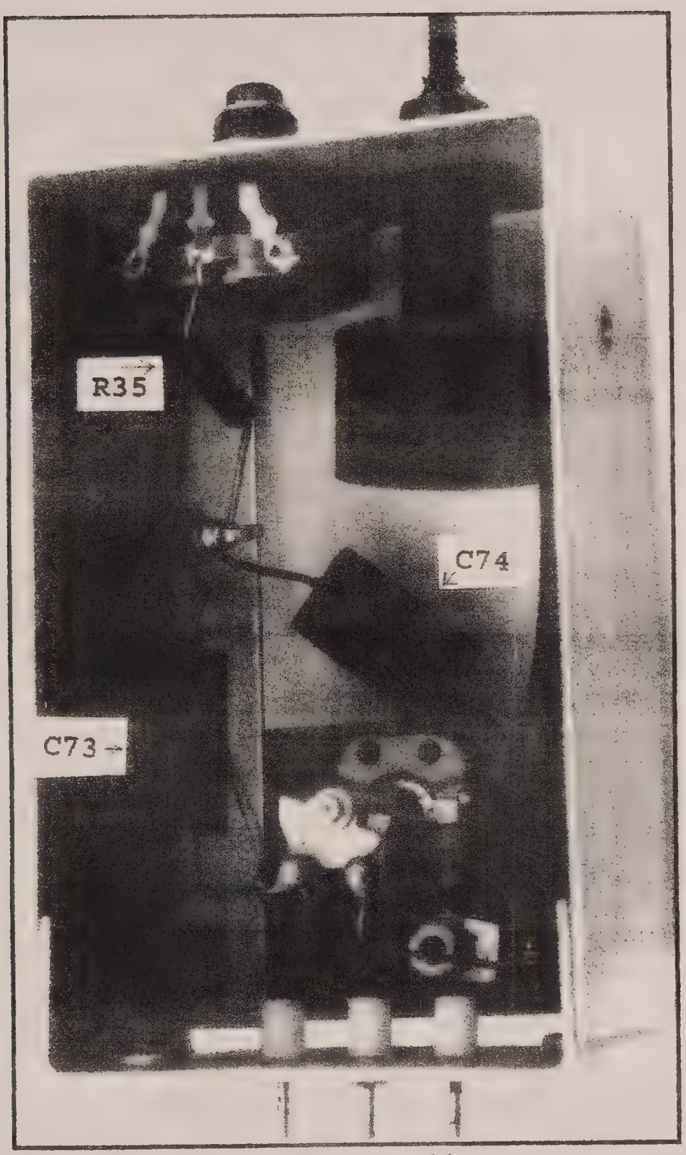

Figure 2. Rejection tuning assembly.

capacity of the C72, C73, and C74 network. The depth of the notch is controlled by the series value of resistors R35 and R36. This value controls the amount of regeneration in V7. Note that the value of R35 is 30K. The schematic calls out 33K, which is an error. This was never caught, even in the latest version of the instruction book which is dated 1968.

Heat is what makes the notch filter circuit "noticeably drifty". This is what I had always suspected, and recent measurements have proved my hunch. I removed the filter component assembly from the receiver (see figure 2) so that all of the temperature coefficients could be measured. (It is necessary to first remove the receiver front panel in order to remove the notch filter assembly). L26, R35, C74, and C73 were removed from the assembly, and heated with a hair dryer from an initial 68 degrees F to an average operating temperature of about 120 degrees F, or a total change of about 29 degrees C. The change of value with heat of each part was measured on a General Radio LCR bridge which is accurate to 1/10%.

The filter inductor, L26, had no measurable drift and was reinstalled. Although the capacitors were within 5% at room temperature, C74 had a positive .29% drift (+1021 parts-per-million), and C73 had a +.20% (+700 ppm) drift. While this doesn't sound like much error, it shifts the filter resonance nearly 8 Kc, and greatly lowers the filter Q at 455 Kc.

I did some checking with my usual parts distributors, and it turns out that many of the old temperature compensating capacitors are as scarce as congressional democrats. Phase locked loops don't need 'em! So, many different types of capacitors were checked for thermal stability on my trusty GR bridge. Disk ceramics were the worst, as expected. Next to worst were plastic capacitors, the mylars and polystyrene/polypropolene types. I tried some NOS mica "postage stamp" caps and the results got encouraging, but I couldn't find enough of them to do a good job of

continued next page

75A-4 Rejection Notch Stability from previous page

Temperature Coefficient Tolerances

Temperature Coeff. (ppm/degree C)	Tolerance (ppm)
P100	+-30
P030	+-30
NPO	+-30
N030	+-30
N050	+-30
N220	+-30
N330	+-60
N470	+-60
N750	+-120
N1500	+-120

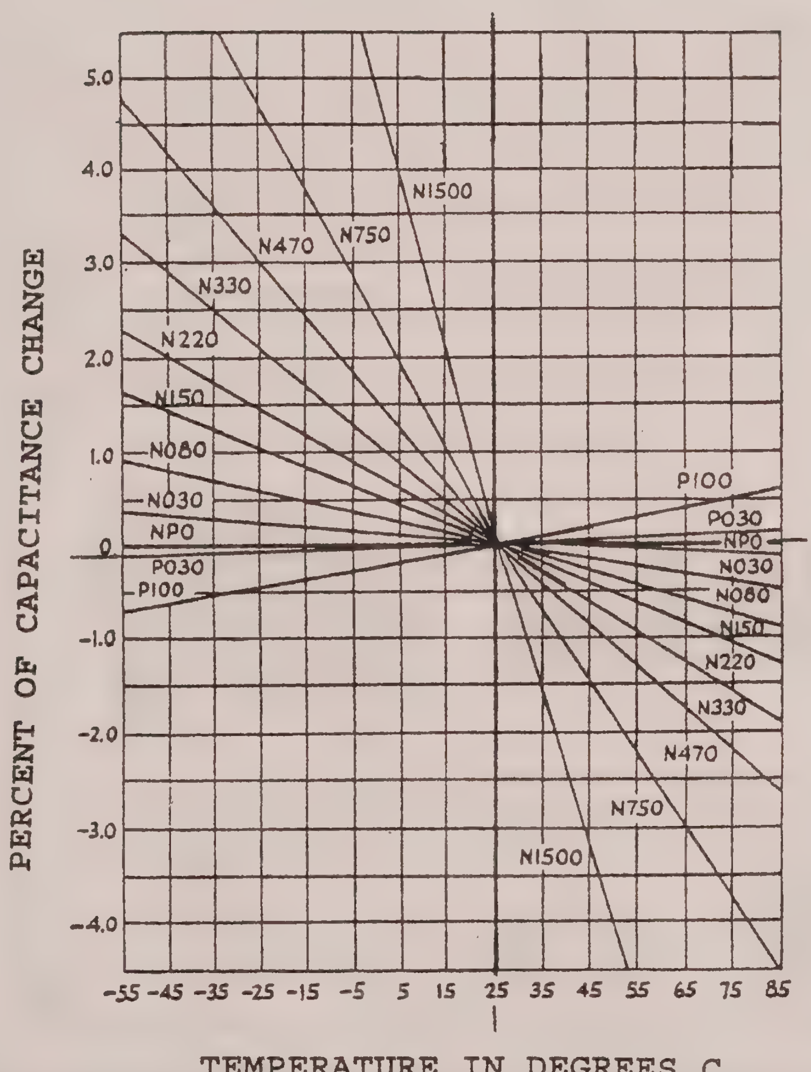

Figure 3. From QST, December 1963.

matching. Contrary to "conventional wisdom", the type that I found with the best thermal stability was 2%, 1000 volt, dipped silver micas. I bought a dozen of them, and got two with capacity values within 1/2%, and no measurable thermal drift, even when heated into the 'real hot' category. These two were soldered in, following the original layout.

Figure 3 is some general reference material regarding temperature compensating capacitors.

R35, even though it was originally a precision value resistor, had a -1.5% negative temperature coefficient, or about a drift of -2974 ppm. Its ohmic value at room temperature was within 1%, as specified in the parts list. I didn't calculate the amount of resistance necessary to produce a given change in feedback, but just replaced it. Generally, the larger a resistor is, the more stable it is. Luckily, there is plenty of room inside the filter component can for big resistors. R35 was replaced with a new 2 watt, 30K, metal film resistor which measured a -.1% change in value with heat. This is a 93% improvement in feedback stability. Modern metal film resistors are temperature stable, and the 2% tolerance distributor pack I bought had one resistor which was exactly 30K. Every resistor in the pack was stable. I'm now using metal film resistors throughout my 75A-4 in the critical locations, such as plate loads, screen voltage dividers, cathode bias, etc. The metal films have eliminated my S-meter zero adjustment drift, and have greatly stabilized the calibration oscillator. Most of the 1957-era carbon-composition resistors originally in these circuits are extremely unstable, in some cases drifting by over 100%.

What a change! With the new parts installed, the notch stays as sharp and stable as it is when first aligned. It's possible to achieve a stable notch deeper than 70 dB when C73 and C74 are well matched in capacitance. Using the notch filter in combination with the passband tuning and the mechanical filters, I say so long and good-bye to QRM! ER

The ER, WAS-AM Award designed by Rob Brownstein, NS6V.